CULTURAL MODELS, GRAIN-FARM MANAGEMENT, AND AGRICULTURAL NUTRIENT RUNOFF: A MARYLAND CASE STUDY OF THE ROLE OF CULTURE IN NUTRIENT-MANAGEMENT POLICY

BY

C2009
R. Shawn Maloney

Submitted to the graduate degree program in Anthropology and the
Graduate Faculty of the University of Kansas
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy.

____
Dr. Donald D. Stull, Chair
Department of Anthropology, University of Kansas

____
Dr. Michael Paolisso
Department of Anthropology, University of Maryland

____
Dr. Bartholomew C. Dean
Department of Anthropology, University of Kansas

____
Dr. Karl Brooks
Department of History, University of Kansas

____
Dr. Jane W. Gibson
Department of Anthropology, University of Kansas

Date defended:______________________________
May 11, 2009

The Dissertation Committee for R. Shawn Maloney certifies
that this is the approved version of the following dissertation:

CULTURAL MODELS, GRAIN-FARM MANAGEMENT, AND AGRICULTURAL NUTRIENT RUNOFF: A MARYLAND CASE STUDY OF THE ROLE OF CULTURE IN NUTRIENT-MANAGEMENT POLICY

Committee:

____
Dr. Donald D. Stull, Chair
Department of Anthropology, University of Kansas

____
Dr. Michael Paolisso
Department of Anthropology, University of Maryland

____
Dr. Bartholomew C. Dean
Department of Anthropology, University of Kansas

____
Dr. Karl Brooks
Department of History, University of Kansas

____
Dr. Jane W. Gibson
Department of Anthropology, University of Kansas

Date approved:__________________________________
May 12, 2009

Abstract

Government agencies responsible for monitoring the health of U.S. waterways report that nonpoint-source pollution from agricultural nutrient runoff is one of America's greatest water-quality threats. Federal agencies and states have partnered to develop nutrient-management policies and programs to reduce farm runoff. These efforts are complicated by the fact that policy decisions are made in an environment with limited resources, imperfect scientific knowledge, and diverse interests and understandings. This increases the likelihood that participants in the policy-making process will have different understandings of environmental problems and preferences for addressing them. Thus, there is a critical need for cooperation and collaboration in creating and implementing nutrient-management policies. In particular, it is important for policy makers to work collaboratively with farmers because nutrient-management policy goals cannot be achieved without their support for and full participation in policy programs.

I contend that the success of nutrient-management policy efforts can be enhanced by greater knowledge of the cultural models that shape farmers' management beliefs and practices and inform their understandings of themselves and their relationship to the world. By situating policy efforts and proposals within the context of farmers' compelling cultural models, policy makers are more likely to create nutrient-management policy that farmers are willing to

support and adopt. This in turn increases the likelihood that environmental goals will be achieved. A key element of this strategy is to successfully link policy ideas and practices with farmers' shared "goal-schemas" and leverage the motivational force associated with them to gain their support.

To explore my contention that farmer cultural models play a central role in informing and directing their farm-management decisions, and that knowledge of these models can serve a valuable function in helping policy makers create more effective nutrient-management policies and programs, I draw on research I conducted in the Chesapeake Bay watershed with Maryland grain farmers from 1998 to 2001. The time period and focus of my research are particularly relevant to nutrient-management policy studies because they coincide with a highly contested nutrient-management policy debate in Maryland that resulted in the passage of the nation's most comprehensive environmental regulations to manage agricultural nutrient runoff.

Acknowledgments

First and foremost, I would like to thank Maryland Lower Eastern Shore farmers and poultry growers who graciously set aside significant time (often during their busiest seasons) to share their knowledge of their craft and related issues. Without their patience, enthusiasm, and participation, this dissertation would not have been possible. I would also like to extend my gratitude to the numerous state agency personnel, university staff, and interest-group representatives who enriched my understanding of agricultural and environmental issues in Maryland. Specifically, I would like to recognize the following groups (in alphabetical order) for their assistance: Chesapeake Bay Foundation; Delmarva Farmer; Delmarva Poultry Industry, Inc.; Eastern Shore Land Conservancy; Harry R. Hughes Center for Agro-Ecology, Inc.; Maryland Cooperative Extension; Maryland Departments of Agriculture, Environment, and Natural Resources; Maryland Farm Bureau; Maryland Sea Grant; and the Somerset, Wicomico, and Worcester County Farm Bureau Chapters.

My dissertation research was part of a larger study spearheaded by Michael Paolisso and Erve Chambers in the Department of Anthropology at the University of Maryland. Their guidance, support, and friendship have been invaluable to me. Throughout my Ph.D. program, their wisdom and encouragement sustained and motivated my academic pursuits. I am particularly

indebted to Dr. Paolisso for the significant role he played as a committee member in the development of my dissertation.

I am also deeply beholden to Don Stull, my mentor, friend, and chair of my dissertation committee. Under his tutelage, Dr. Stull provided me with the knowledge I needed to become an effective educator and a competent scholar. One of the greatest gifts he gave me was instruction in the art of writing. Drawing on his expert knowledge of and passion for literary composition, he challenged me to think more critically and creatively about my writing. In doing this, Dr. Stull spent countless hours of his own time editing and commenting on my manuscripts. He continued this practice while shepherding the completion of my dissertation, which greatly improved its quality. I am a better educator, scholar, and person because of his efforts.

In addition, three other committee members deserve special thanks: Jane Gibson, Bart Dean, and Karl Brooks. Drs. Gibson and Dean gave me the freedom and support to explore my intellectual interests and the guidance necessary to make sense of them. And their dissertation insights allowed me to understand my research in new, meaningful ways. Dr. Brooks was no less helpful. As the outside reader on my committee, he generously offered his time and provided input unique to his discipline and professional experience that gave me the ability to comprehend my work in broader contexts. Moreover, each inspired me to further pursue my dissertation interests.

I would also like to thank the many other individuals whose assistance contributed to the successful completion of my dissertation and Ph.D. program. Too numerous to list, these friends, family members, colleagues, and mentors provided the intellectual, social, emotional, financial, and administrative support I needed to accomplish my academic goals. The value of their contributions cannot be over stated. In alphabetical order, the following individuals are just some of the people who deserve recognition: Carol Archinal, Norberto Baldi, Phillip Berrill, Stephen Brighton, Chambers family, Dawn and Dan Conlisk, Mary D'Agostin, Nicole Dery, Bahman Engheta, Nancy Erickson, Melissa Filippi-Franz, Mark and Wendy Frederick, Brian Garavalia, Meghan Gibbons, Lenz family, Sean and Melissa Macmillan, Rich and Jean Maloney, Shannon and Lisa Maloney, Mark McGonigle and Karin Masci, Bill Mckinney, Modern Times Coffee House staff, Jane Packard, Paolisso family, Adam Powell, Dan Prosperi, Sydney and Kirti Reddy, Gloria Reece, Judy Ross, Heather Schacht-Reisinger, Paul Shackel, Chaya Spears, Laura Stull, Raymond van Over, John Vance, Rachel Watkins, Pris Weeks, and Lori Whiteman.

Finally, I owe a debt of gratitude to the organizations (and specific individuals within them) that funded my dissertation research and Ph.D. program. Two grants from the National Science Foundation's (NSF's) Cultural Anthropology Program (award nos. 9813448 and 9904928) and one from a joint NSF and U.S. Environmental Protection Agency (EPA) program--"Environmental Research Decision-Making and Valuation for Environmental Policy"--(award no.

9975825) were my primary research-funding sources. In addition, I received a grant from the Society for Applied Anthropology (SfAA) and EPA's joint Environmental Anthropology Fellowship Program that aided my research efforts. I am also thankful for the financial support provided by the University of Maryland's Department of Anthropology, College of Behavioral and Social Sciences, and Sea Grant program. Furthermore, I am eternally grateful for the teaching and editorial jobs that Don Stull, the Department of Anthropology at the University of Kansas (KU), and *Human Organization* (SfAA journal) provided me, which paid for most of my tuition and living expenses while at KU.

Even though my dissertation was made possible by these funding organizations, and was influenced by the mentors and colleagues who assisted me with it, the statements, findings, and conclusions that constitute it are my own and do not necessarily reflect their views.

Table of Contents

Figures and Tables

Figures

Tables

List of Acronyms

AIR	annual implementation report
BMP	best-management practice
CBF	Chesapeake Bay Foundation
CBP	Chesapeake Bay Program
CRB	Choptank River Basin (ES subwatershed)
DPI	Delmarva Poultry Industry, Inc.
EPA	U.S. Environmental Protection Agency
ES	Eastern Shore (Maryland)
FIV	fertility index value
LDP	loan-deficiency payment
LES	Lower Eastern Shore (Maryland)
LESB	Lower Eastern Shore Basin (ES subwatershed)
MARB	Mississippi-Atchafalaya River Basin
MCE	Maryland Cooperative Extension
MCESTL	Maryland Cooperative Extension Soil Testing Laboratory
MDA	Maryland Department of Agriculture
MFB	Maryland Farm Bureau
MNMP	Maryland Nutrient-Management Program
MRGOMWNTF	Mississippi River/Gulf of Mexico Watershed Nutrient Task Force
N	nitrogen
NGOM	Northern Gulf of Mexico
NMAC	Nutrient Management Advisory Committee
NMP	nutrient-management plan
NMRs	nutrient-management regulations
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
P	phosphorus
PSI	phosphorus site index
ROA	rate of return on farm assets
SAV	submerged aquatic vegetation
SEM	scanning electron microscopy
STAC	Scientific and Technical Advisory Committee
TMDL	total maximum daily load
UESB	Upper Eastern Shore Basin (ES subwatershed)
UMCES	University of Maryland Center for Environmental Science
UMD	University of Maryland
USDA	U.S. Department of Agriculture
WQIA	Water Quality Improvement Act of 1998

Chapter 1

Introduction

In early 1998, just after the 25th anniversary of the 1972 Clean Water Act, U.S. Environmental Protection Agency (EPA) Administrator Carol Browner and U.S. Department of Agriculture (USDA) Secretary Dan Glickman reported in their Clean Water Action Plan that 40 percent of the nation's waterways were still impaired and unsafe for fishing and swimming (Browner and Glickman 1998). They argued that America's progress in addressing point-source pollution from factories and sewage-treatment plants had not been matched by efforts to control nonpoint-source pollution from urban and rural areas (see also EPA 1998). In fact, they concluded that the nation's remaining water-quality problems were predominately from nonpoint-source pollution and that agricultural runoff was the most extensive source of water pollution in the U.S., affecting "70 percent of impaired rivers and streams and 49 percent of impaired lake acres" (Browner and Glickman 1998:9). Nutrient (organic and inorganic nitrogen and phosphorus fertilizers) and sediment (soil) runoff from agricultural operations were found to be the two pollutants most responsible for agriculture's deleterious effects to U.S. waterways (Browner and Glickman 1998; EPA 2000a, b; Ribaudo and Johansson 2006).

A decade later, state and federal agencies responsible for monitoring the health of U.S. waterways continue to report that nonpoint-source pollution from agricultural runoff is still America's greatest water-quality threat. For example, in EPA's most recent national water-quality reports to Congress, which summarize state water-quality assessments, nonpoint-source pollution is recognized as the leading cause of surface-water pollution, and agriculture is noted as the most identifiable and widespread source of water pollution for assessed rivers and lakes. Depending on waterways assessed, states report that agriculture roughly affects 35 to 48 percent of impaired river miles and 30 to 41 percent of impaired lake acres (EPA 2003, 2007a, b; Ribaudo and Johansson 2006).

Environmental agencies, scientists, and advocates have voiced particular concern over agricultural nutrient runoff and its deleterious effects on estuarine and marine organisms as a result of eutrophication and hypoxia. Eutrophication is "the process of excess nutrients accelerating the growth of algae, ultimately depleting the water of dissolved oxygen"; hypoxia is "a condition in which oxygen levels in water are very low" (CBP n.d.). Findings from National Oceanic and Atmospheric Administration (NOAA) research reinforce environmental interest group concern over agricultural nutrient runoff by concluding that it is responsible for highly eutrophic conditions in 44 percent of major U.S. estuaries (Ribaudo and Johansson 2006). These conditions also set the stage for harmful algal blooms and hypoxic zones, all of which are present in U.S. coastal waters (ibid.). And nowhere is the scope and severity of agricultural nutrient runoff's eutrophic and hypoxic effects more evident than in the Northern Gulf of Mexico

(NGOM), the Chesapeake Bay, and their watersheds--two of the largest in the U.S. (CBP 2004; SABHP 2007a, b).

In brief, the NGOM receives waters from the Mississippi-Atchafalaya River Basin (MARB; 1.2 million square miles), which drains 40 percent of the contiguous U.S.; produces most of the grain (58% of basin is cropland), cattle, and hogs grown in the U.S.; and receives the majority of fertilizers and pesticides applied to U.S. cropland. Agriculture is thought to be the largest source of nutrient runoff to MARB and NGOM, contributing more than 50 percent of all nutrients. Scientists suggest that these large nutrient contributions are the primary cause of the growing hypoxic zone in the NGOM, which measured about 8,000 square miles in 2008, roughly the size of New Jersey. The 2008 hypoxic zone is one of the largest since measurements began in 1985 (Achenbach 2008; LiveScience Staff 2008). As suggested, hypoxia is problematic because it depletes dissolved oxygen in the water, making it unable to support many estuarine and marine organisms, which has negative consequences not only for those organisms immediately affected, but also for the seafood and recreational industries that are dependent upon their health for their success (Goolsby et al. 1999; MRGOMWNTF 2008; SABHP 2007a, b).

The Chesapeake Bay is the largest estuary in the U.S., supporting 3,600 species of plants, fish, and animals. Its watershed encompasses about one-sixth of the eastern seaboard (64,000 square miles; CBP 2004; Sims and Coale 2002). As with MARB and NGOM, nonpoint-source pollution in the form of agricultural nutrient runoff is also considered to be the most significant threat to bay water quality, resulting in eutrophication and hypoxia that diminishes marine life and threatens water-related industries (Boesch, Brinsfield, and Magnien 2001; MCE 2006a; Sims and Coale 2002; STAC 2004). Only 33 percent of the watershed is used for agriculture, but scientists estimate that it is the largest source of nutrient pollution to the bay (Sims and Coale 2002; STAC 2004). A recent Chesapeake Bay Program (CBP) report indicates that up to 46 percent of nitrogen and phosphorus loads to the bay come from agriculture (CBP 2008a). And scientists believe that agricultural nutrient runoff is a major contributor to the bay's reoccurring and growing hypoxic zone, which was predicted in July 2008 to be the sixth largest in recorded history (ScienceDaily 2008). Underscoring the role that nutrient runoff plays in bay health problems, a 2008 report published jointly by the University of Maryland Center for Environmental Science (UMCES) and NOAA gave a "C-" grade to bay health in 2007 (UMCES and NOAA 2008).

A major source of agricultural nutrient runoff concern in the bay watershed is manure from poultry production. Five of the six states within the watershed are among the top 16 broiler producers in the U.S.--Delaware (7), Virginia (11), Maryland (12), Pennsylvania (14), and West Virginia (16)--producing more than one billion birds in 2006 (DPI 2007). The concentrated nature of the bay watershed's poultry industry, especially on the Delmarva Peninsula (comprised of Delaware and parts of Maryland and Virginia east of the bay), which produces more poultry manure than necessary to fertilize Delmarva crops, increases the likelihood that manure, in the form of nutrient runoff, will find its way to the bay and its tributaries.

Federal environmental and agricultural agencies, states, and other interested parties have partnered to develop nutrient-management policies and programs to help reduce agriculture's nutrient loads to U.S. waterways. In this effort, more than 30 states have developed laws that regulate agricultural nutrients under certain conditions, and a plethora of voluntary federal, state, and local programs are offered that use education, technical assistance, and financial incentives to encourage farmers to adopt best-management practices (BMPs) and other conservation measures designed to reduce their nutrient-runoff contributions (Caswell et al. 2001; Ribaudo, Horan, and Smith 1999; Ribaudo and Johansson 2006). Despite these activities, the very nature of nonpoint-source pollutants like agricultural nutrient runoff, and the political and scientific issues related to nutrient-management policy, make nutrient runoff extremely challenging to address. For example, in terms of the former, Ribaudo and Johansson (2006:39) note that:

- Nonpoint emissions are generated diffusely over a broad land area. These emissions leave from fields in so many places that it is generally not cost effective to accurately monitor emissions using current technology.

- Nonpoint emissions (and their transport to water or other resources) are subject to significant natural variability due to weather-related events and other environmental characteristics.

- Nonpoint emissions and the associated water quality impacts depends [sic] on many site-specific characteristics, such as soil type, topography, proximity to the water resource, climate, etc.

- Nonpoint pollution problems are often characterized by a very large number of nonpoint polluters.

And with regard to the political and scientific challenges posed by nutrient-management policy efforts, policy makers face many decision-making constraints and competing interests in creating effective nutrient-management policy. For instance, government entities with the responsibility to address agricultural nutrient runoff are confronted with the need to use considerable financial and human resources to investigate and understand the incredibly complex biological, ecological, and human factors that underlie nutrient-runoff concerns so that appropriate mitigating policy measures can be created and implemented. Unfortunately, the policy-making process is constrained by finite resources and imperfect scientific knowledge. In many cases, the costs associated with obtaining the necessary information for determining and applying site-specific policies, monitoring input usage and technology choices, and enforcing policy provisions can be substantial and prohibitive (Doering et al. 1999). And because of the complexity of the ecological, biological, and social issues at hand, scientific understandings of them are often incomplete and evolving. These limitations require policy decisions to be made with incomplete or imperfect understandings of the causes and consequences of nutrient-runoff problems and the viability of policy solutions to address them. Further complicating the policy-making process, these efforts integrate policy makers and other interested individuals and groups at multiple jurisdictional levels with varying socioeconomic, educational, and occupational backgrounds. This occurrence raises the strong likelihood that participants in the policy-making process will have different understandings of environmental problems and preferences for addressing them.

Given limited resources, imperfect scientific knowledge, the significant size of watersheds affected, diverse production environments, unpredictable and varying climatic and economic forces, and the wide range of individual and group interests and understandings, there is a critical need for cooperation and collaboration in creating nutrient-management policy. In fact, policy goals cannot be achieved without farmer support for and full participation in policy programs. As discussed, the nature and scope of the agricultural nutrient-runoff problem make it unrealistic that government mandates and agents can successfully force farmers to adopt related policy measures. This is particularly the case when farmers believe that these efforts run counter to their best interests. Thus, if long-term nutrient-runoff reduction goals are to be achieved, it is imperative that federal and state agencies find ways to work collaboratively with farmers to produce nutrient-management policy that not only improves environmental quality, but also addresses farmers' interests and concerns. I believe that cultural analyses and understandings can serve as one of the primary mechanisms to build cooperative and collaborative relationships that achieve both environmental-quality and farm-management goals.

For example, I argue that the success of nutrient-management policy efforts is significantly influenced by the cultural expectations of farmers who must adopt policy-related programs and practices. In other words, drawing on theory from cognitive anthropology (D'Andrade 1995; Strauss and Quinn 1997), I contend that farmers' shared understandings, or cultural models, about farming, farm life, and farmer identity play a pivotal role in their farm-management decisions and support of nutrient-management policies and programs. And through greater knowledge of these shared farmer understandings, I propose that policy makers can more effectively work with farmers to create nutrient-management policies and programs that not only achieve environmental goals, but garner farmer support because they also meet their farm-management needs and reflect their core beliefs and values.

Dissertation Overview

To explore my contention that farmer cultural models play a central role in informing and directing their farm-management decisions, and that knowledge of these cultural models can serve a valuable function in helping policy makers create more effective nutrient-management policies and programs, I draw on research I conducted in the Chesapeake Bay area with Maryland Lower Eastern

Shore (LES) farmers from 1998 to 2001. The time period and focus of my research are particularly relevant to nutrient-management policy studies because they coincide with a highly contested nutrient-management policy debate in Maryland that resulted in the passage of the nation's most comprehensive environmental regulations to manage agricultural nutrient runoff (Paolisso 1999; Simpson n.d.). And at the center of this nutrient-management policy debate was LES farmers' nutrient-management practices: grain farmers' nutrient-application methods and rates, and poultry growers' manure-storage and -disposal practices. I focus on grain farming and related farm-management decisions and practices because Maryland, environmentalists, and other Chesapeake Bay Program partners have identified nutrient runoff from grain fields as the primary source of agricultural nonpoint-source pollution to the bay.[1] As a result, these groups have sought to change grain farmers' nutrient-management practices. My primary data come from semistructured interviews with LES farmers who have significant grain-farm knowledge and experience: full-time grain producers, mixed grain and poultry farmers, retired grain farmers who raise poultry, and poultry growers reared on grain farms who participated in all grain-production activities through early adulthood.

This dissertation begins with a detailed discussion of the cognitive-anthropology theory and method that are the foundation of my analysis. Next, I introduce readers to the Chesapeake Bay study area and those who live within it to give them a better sense of its people, places, and social institutions. Following this discussion, I provide a synopsis of my research. This includes a depiction of my data-collection methods; when, where, and with whom I conducted interviews; the type of data I collected; and my general approach to data analysis. After I have grounded readers in the research setting, I present a detailed account of Chesapeake Bay restoration efforts and Maryland's nutrient-management history. This information provides the necessary backdrop to understand the context that informed both Maryland's and farmers' nutrient-management policy positions. Next, from interviews and public hearings, I construct farmers' cultural model for grain-farm management and the cognitive framework they draw on to evaluate and make farm-management decisions. In this discussion, I explore the role of farmers' management model in informing and motivating their grain-farm decisions and practices, and examine the relationship between the beliefs and practices that comprise this model and components of Maryland's nutrient-management regulations. Also, to better illustrate the motivational force of farmers' grain-farm management model, I explain how links to several higher-level cultural models help to generate and maintain it. Finally, I conclude with a discussion of the policy implications of cognitive theory and farmers' grain-farm management model, and offer insights to consider when creating and implementing nutrient-management policies and programs, as well as others designed to improve the sustainability of our agricultural production system.

It is important to note that the purpose of this dissertation is not to argue for or against voluntary or regulatory approaches to nutrient management. In particular, it is not my intention to make the case for or against Maryland's decision to pursue nutrient-management regulations. Voluntary and regulatory approaches both have their merits and disadvantages, and no consensus has been reached on which approach, or combination of approaches, is best suited for the varying agricultural, ecological, and political contexts that exist. In addition, this dissertation does not make claims about the role of agriculture in contributing to the bay's poor water quality, the extent to which farmers' practices have contributed to this problem, and the degree to which farmers should be held accountable for any deleterious environmental effects. It is clear that agriculture is one of several key sources of bay nutrients and that farmers must play an active role in addressing nutrient runoff if bay water-quality goals are to be met. Furthermore, it is not my purpose to make value judgments about whether or not Maryland's nutrient-management decisions resulted in the unfair treatment of farmers. It is my intent, however, to explore many of these issues through the lens of farmers' cultural model for grain-farm management to better understand how their beliefs and values shaped their views on these issues and influenced their farm-management decisions. A major goal of this cultural analysis then is to explore how knowledge of these core cultural beliefs and values can be used to improve environmental decision making.

Dissertation Contributions

This dissertation contributes to regional and national efforts to address agricultural nutrient runoff and to cognitive anthropology. Despite Chesapeake Bay Program (CBP) partners' (i.e., state and federal environmental and agricultural agencies) voluntary and regulatory programs to reduce nutrient runoff from all sources, they report that it is still a major threat to bay water quality and that significant reductions are needed to meet water-quality goals (Wheeler 2008; White 2008). CBP partners have determined that reducing farm nutrient runoff is by far the most cost-effective way to achieve these goals (CBP 2007). However, insufficient funds exist to pay for all the conservation programs necessary to meet them. And given state economic shortfalls, divided legislative support, and farmer opposition, additional regulatory options to compel farmers to adopt more stringent nutrient-management practices face considerable legislative obstacles.

Moreover, CBP program partners are under increasing pressure to reduce bay nutrient levels (Fahrenthold 2008). By 2010, EPA is required to create and enforce total maximum daily load (TMDL) requirements for nutrient levels in bay-area waters (Wood 2008). State efforts to meet new TMDL limits for nutrients may prove to be the most challenging water-quality improvement campaign in bay history. Thus, CBP partners have considerable need for innovative strategies to improve participation in a wide range of nutrient-management programs, and the cultural-models approach can help facilitate farmer support for these programs. In fact, CBP partners are currently working on a major baywide nutrient-reduction initiative to enhance farmer participation in cover-crop programs (CCEWG 2008). My findings could directly benefit this effort.

Hypoxia in the Northern Gulf of Mexico (NGOM) is a direct result of agricultural nutrient runoff in the Mississippi-Atchafalaya River Basin (MARB). Collaborative working relationships between policy makers and farmers will be essential to effective nutrient-management programs. The Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (MRGOMWNTF) has adopted an aggressive plan to decrease the size of the hypoxic zone that relies heavily on voluntary programs and substantial farmer cooperation to reduce agricultural nutrient runoff. Enormous financial, jurisdictional, scientific, and policy challenges confront the effort, and the outcome is uncertain (MRGOMWNTF 2008; SABHP 2007a, b). What is certain, however, is the need to create nutrient-management policy that farmers are willing to support. My dissertation research offers policy-making tools and policy-relevant findings that could aid efforts to garner farmer support for and participation in nutrient-management programs.

Finally, this dissertation adds to cognitive anthropology in a number of areas. First, it contributes to efforts to better operationalize the "culture" concept in anthropological studies. Second, it provides further evidence of how our shared cognitive frameworks, through linkages with emotion and motivation, shape our cultural understandings and direct our behavior. Third, this dissertation adds to the knowledge of how cultural models can be determined and illustrated. Lastly, this dissertation makes an important contribution to the application of cognitive theory and cultural-model data to policy making.

Chapter 2

Cultural-Models Approach

My research with Maryland Lower Eastern Shore (LES) farmers was part of a larger research effort conducted by the Department of Anthropology at the University of Maryland. The general intent of this research was to explore the cultural issues surrounding Maryland's efforts to address water-quality concerns related to the 1997 toxic outbreak of *Pfiesteria piscicida* in LES waterways and its hypothesized link to agricultural nutrient runoff (Paolisso 1999; Paolisso and Chambers 2001). Funding for this research came from the National Science Foundation (NSF), U.S. Environmental Protection Agency (EPA), Maryland Sea Grant, and the Society for Applied Anthropology's Environmental Fellowship Program (Maloney 1998; Paolisso, Chambers, and Maloney 1998a, b, 1999a, b).

In our funded proposals we outlined a research agenda to investigate how environmental professionals', farmers', and watermen's cultural understandings of environment, pollution, *Pfiesteria*, and natural-resource management influenced their views on policy measures to address water-quality threats. More specifically, we were interested in determining the extent to which these groups used different or complementary sets of cultural beliefs and values to understand these environmental and policy issues. Since these groups were locked in heated debates over how best to address water-quality concerns, we were also interested in exploring how this cultural knowledge could be used to promote dialogue and cooperation.

One of our central hypotheses was that environmental professionals', farmers', and watermen's explicit cultural knowledge of environment, pollution, *Pfiesteria*, and natural-resource management was insufficient to understand their beliefs and values around these issues. Instead, we argued for a need to understand the cultural models--which are largely comprised of implicit, tacit, taken-for-granted shared knowledge--that underlie these explicit cultural beliefs and values. A widely cited and generally accepted definition of cultural models is offered by Naomi Quinn and Dorothy Holland (1987:4; emphasis in original):

> *Cultural models* are presupposed, taken-for-granted models of the world that are widely shared (although not to the exclusion of other, alternative models) by the members of a society and that play an enormous role in their understanding of that world and their behavior in it.

In the following sections, I discuss the theoretical and methodological approaches within cognitive anthropology that influenced my use of cultural models in this dissertation.

It's All About Meaning

A central focus of cognitive anthropology is the study of meaning (D'Andrade 1995; Strauss and Quinn 1997). There are two types of meaning:

personal and cultural. Personal meaning is "the interpretation evoked in a person by an object or event at a given time" (Strauss and Quinn 1997:6). And cultural meaning is "the typical . . . interpretation of some type of object or event evoked in people as a result of their similar life experiences" (ibid.). The major differences between the two are that cultural meanings, unlike personal ones, are the "frequently recurring and widely shared [more or less] aspects of" typical interpretations that are the result of shared life experiences (ibid.). According to Strauss and Quinn (1997:6), the depiction of cultural meanings as "typical interpretations" illustrates that they have a modal quality. Because cultural meanings are the result of shared life experiences, "a different interpretation would be evoked in people with different characteristic life experiences."

Personal and cultural meanings share at least three salient characteristics: meanings are interpretations of objects and events (or aspects of experience in general), meanings are momentary states (i.e., interpretations made at a given time), and meanings are evoked in people. Strauss and Quinn (1997:6) posit that an individual's interpretation of an object or event can include "an identification of it and expectations regarding it, and, often, a feeling about it and motivations to respond to it." Thus, meaning can range from simple representations to declarations for action.

Cognitive theory holds that meaning is the product of the interplay between what a person experiences at a given moment and the nature of the interpretive framework he draws on at the same moment--which is the cumulative result of his past experiences--to make sense of the experience (Strauss and Quinn 1997). A person's interpretive framework can be further broken down to the interaction between two relatively stable structures: *intrapersonal* mental structures (i.e., schemas) and *extrapersonal* world structures (i.e., publicly observable human objects, events, and learned practices). Strauss and Quinn (1997:10), quoting Hannerz (1992), explain how intrapersonal and extrapersonal structures interact to create meaning:

> On the one hand, culture resides in a set of publicly meaningful forms, which can most often be seen or heard, or are somewhat less frequently known through touch, smell, or taste, if not through some combination of senses. On the other hand, these overt forms are only rendered meaningful because human minds contain the instruments for their interpretation. The cultural flow thus consists of the externalization of meaning which individuals produce through arrangements of overt forms, and the interpretations which individuals made of such displays--those of others as well as their own.

Thus, meanings are ultimately a product of the mind, but are created in the interplay between psychological states and social constructions. In Strauss and Quinn's (1997:6) own words: "Our definition also makes meanings psychological (they are cognitive-emotional responses), but highlights the fact that meanings are the product of current events in the public world interacting with mental structures, which are in turn the product of previous such interaction with the public world."

In addition, cognitive theory suggests that because our worlds and schemas are relatively stable (more on this later), the meanings--whether personal or shared--we derive from their interplay tend to arise over and over again (Strauss and Quinn 1997). Strauss and Quinn (1997:54) explain that even though meanings are "the associations elicited in actors at the moment," they are still relatively stable because the associations are "guided by the actors' well-learned understandings."

Strauss and Quinn (1997), as well as D'Andrade (1995), argue that meaning must reside in people's minds because there is no other place it can realistically and concretely be. They note that if meanings influence action, then they must be in the mind to affect it because we must first know to be able to do. Thus, meanings cannot concretely and operationally exist outside the mind as some "free-floating abstract entity" (Strauss and Quinn 1997:7) or in a system of signs or symbols associated with publicly observable objects and events.

Finally, the idea that meanings are psychological is important because people's interpretive frameworks (i.e., the outcome of ongoing interactions between the extrapersonal and intrapersonal realms) become constituted in their schemas (or mental structures). In creating meaning, individuals draw on their schemas (also known as cultural models in some instances) to interpret the objects and events they experience (D'Andrade 1995; Strauss and Quinn 1997).

Schemas and Cultural Models

Schemas are both learned (idiosyncratic and cultural) and innate mental structures that interact in complex ways to mediate information processing by organizing related pieces of our knowledge. Schemas are not distinct things, but rather "collections of elements that work together to process information at a given time" (Strauss and Quinn 1997:49). These collections of elements can be thought of as networks of strongly connected cognitive elements that represent a generic version of (some part of) the world built up from experience and stored in memory. Schemas are thought to be generic (i.e., prototypical) because they are the "cumulative outcome of just those features of successive experiences that are alike" (Quinn 2005b:38). The generic knowledge that schemas represent may be of any sort--"from parts to wholes, simple to complex, concrete to abstract" (Strauss and Quinn 1997:49). Schema composition can be equally diverse, containing words and many different kinds of experiences, including those that are "unlabeled as well as labeled, inarticulate as well as well-theorized, felt as well as cognized" (Quinn 2005b:38). Also, schemas are typically comprised of and linked to other schemas. Depending on the context of the experience to be interpreted, different networks of schemas are activated or drawn on to create meaning.

Stable and Flexible Mental Structures

Cognitive theory contends that schemas are both relatively stable and flexible mental structures. Schemas are relatively stable in part because they are prototypical by definition and built on similar repeated experiences. Thus, as the cumulative outcome of similar elements of reoccurring experiences, schemas are not easily altered. Also, schemas are self-reinforcing, so that the more established schemas become over time, the more resistant they are to change. In fact, schemas are more likely to influence our interpretations of new experiences than to be altered by them (D'Andrade 1992; Quinn 2005c; Quinn and Holland 1987; Strauss and Quinn 1997). And new cultural understandings are always "incorporated, rejected, and remade in terms of previous schemas" (Strauss and Quinn 1997:25-26).

Schemas are also more or less durable because there is a neural basis for learning that facilitates the acquisition and maintenance of schemas. Strauss and Quinn (1997:90) explain the neural learning process this way: "When neurons are consistently activated by co-occurring features of experience, physical changes in the neurons strengthen the connections between and among them. Thereafter, if one of those neurons is activated, it will be more likely to activate another in that group."

Schemas are associated with the strong neural connections and patterned networks that develop in the brain as a result of our repeated experiences. And because of the strength of these neural connections and networks, when similar subsequent experiences occur they are likely to activate the same connections and networks and related schemas (Strauss and Quinn 1997). Thus, schemas become durable in part because synaptic changes are not easily undone.

Furthermore, Strauss and Quinn (1997) note that our world is organized to facilitate repeat experiences that lead to strong neural connections and patterned networks. They posit that growing up in and interacting with a particularly shaped environment creates distinctive patterns of experience that correspond to specific neural changes and schemas. If these neural changes lead to durable neural networks and schemas, it is highly likely that a similar response will be repeatedly evoked when they are activated (ibid.).

Schemas are relatively stable, but they are also flexible and can change as a result of new experiences. For example, changes in the world can lead to new patterns of strong neural connections (Strauss and Quinn 1997). However, previous learning and neural patterns are not destroyed. Also, schemas can be flexible without significantly altering them and compromising their stability. In other words, stability and flexibility are not mutually exclusive characteristics of schemas. As Strauss and Quinn (1997) explain, schemas are learned networks of strongly connected cognitive elements, and depending on the unique attributes of the experience encountered, different parts of the network can be activated and applied to fit the context. This divergence from some schema's prototypical cognitive network does not necessarily alter it, but becomes one of the many cumulative experiences that shape it (ibid.).

Tacit Understandings

Schemas are largely tacit, taken-for-granted assumptions (Quinn 2005b, c). As Quinn and Holland (1987:14) explain:

> This underlying cultural knowledge is, to use Hutchins's (1980:12) words, "often transparent to those who use it. Once learned, it becomes what one *sees with*, but seldom what one *sees*." This "referential transparency" (ibid.) . . . causes cultural knowledge to go unquestioned by its bearer [emphasis in original].

Even though schemas are normally outside individual awareness, they are not barred from consciousness and can be foregrounded and described to a limited degree in some instances (Strauss and Quinn 1997). D'Andrade (1995:172) explains it this way:

> People are much better at *using* such models [i.e., cultural schemas] than describing them. Informants usually can give a partial account of the model, especially if asked a specific question about how a piece of the model works. But they typically cannot provide an over-all account of the model; the model seems more like a set of *procedures* they know how to use than like *declarative* knowledge they can state [emphasis in original].

Thus, people are rarely able to fully articulate their schemas. Quinn (2005c) notes that individuals' inability to articulate their schemas is a reflection of the fact that our formal (explicit) and informal (implicit) learning experiences often occur in nonlinguistic contexts (i.e., unattached to language). For example, cultural knowledge is explicitly imparted through consciously chosen actions (i.e., instructing by formal demonstration), as well as implicitly conveyed through behavioral modeling and interaction with the socially constructed world (Strauss and Quinn 1997). In these instances, language may be involved in the learning experience, but does not codify it. Quinn (2005c:4) adds, "Only under special circumstances (such as some kinds of formal teaching) does experience come to us codified in language or is it translated into language." And in most learning settings where language is used to codify experience, it only codifies part of the learning experience (Strauss and Quinn 1997). For example, in "learning by guided discovery":

> You try some of it by yourself, and other people help by giving occasional procedural advice and crucial instruction in classification when you get stuck. . . . Looking at cross-cultural studies of socialization, one is struck with both the small amount of explicit step by step instruction and the large amount of occasional correction that characterizes cultural learning all over the world (Strauss and Quinn 1997:77 quoting D'Andrade 1981).

And even when experience is codified in language, it can be misleading and ambiguous, requiring other forms of experiential learning to interpret. In addition, emotions are an integral part of all learning experiences and are not easily captured by linguistic processes. Therefore, much of experiential learning is not codified in language and produces schemas that are not easily articulated.

Role of Schemas

Given their ability to readily organize and relate our innumerable experiences, schemas are powerful interpretive devices (D'Andrade 1995; Strauss and Quinn 1997). As such, Strauss and Quinn (1997:49) suggest that we draw on schemas to "reconstruct our memories of past events, determine the meanings we impart to ongoing experience, and give us expectations for the future." Similarly stated, Quinn and Holland (1987:6) note that schemas "frame experience, supplying interpretations of that experience and inferences about it, and goals for action." As an interpretive tool, schemas are not only important as a recognition (or situation-defining) device, but also play a valuable role in guiding and instigating action (D'Andrade 1995; Quinn 1992). Holly Mathews (2005:112) echoes this sentiment by suggesting that when schemas are wedded to affect (i.e., emotion), they "supply the motivational force individuals need to take action in the world." Quinn and Holland (1987:6-7) provide an excellent summary of the role schemas play in affecting action:

> Sometimes these [schemas] serve to set goals for action, sometimes to plan the attainment of said goals, sometimes to direct the actualization of these goals, sometimes to make sense of the actions and fathom the goals of others, and sometimes to produce verbalizations that may play various parts in all these projects as well as in the subsequent interpretation of what has happened.

In addition, schemas also serve as a mechanism to fill in missing or ambiguous information (Quinn and Holland 1987; Strauss and Quinn 1997). For example, shared schemas greatly aid conversation by allowing speakers to communicate considerable information in relatively few words because much of what is left unsaid is assumed to be understood. As Quinn and Holland (1987:25) explain, "The capability, afforded by proposition-schemas, of dropping out this detailed knowledge allows speakers to present relatively lengthy arguments and arrive at their conclusions with reasonable economy."

One reason we are able to use our well-established schemas to fill in missing or ambiguous information is because once a few of their elements have been activated by experience, they often become fully activated. A result of this full-schema activation is that "we may experience all the features of the typical event even when only some of its features are present" (Strauss and Quinn 1997:90). In this instance, schemas may provide information that would otherwise not exist or may prevent other information from surfacing. In the latter case, disconfirming evidence can be blocked and original expectations can be reinforced (ibid.).

Cultural Schemas and Models

Cognitive schemas can be both idiosyncratic and cultural. Idiosyncratic schemas are those derived from experiences that are unique to each individual. However, a great many of our schemas are cultural in that they are built up from shared experiences (D'Andrade 1995; Strauss and Quinn 1997). Quinn and Holland (1987:3) say that "A very large proportion of what we know and believe we derive from these shared models that specify what is in the world and how it works."

So many of our schemas are cultural because we live in a socially constructed world where most of our thoughts have been learned from others

(D'Andrade 1995; Strauss and Quinn 1997). Thus, cultural schemas play a critical role in our lives because we need shared understandings to successfully negotiate our humanly mediated environments to survive. Strauss and Quinn (1997:49) make this point: "Without these learned expectations regarding the way things usually go, it would be impossible to get anything done, plan for the future, or even interpret what is happening; and without schemas that were at least partly shared, social interaction would be impossible as well."

Cultural schemas are also frequently referred to as "cultural models" (D'Andrade 1995; Quinn and Holland 1987; Strauss and Quinn 1997). One reason for the close association between cultural schemas and cultural models is because the latter was derived from earlier work done on schemas (D'Andrade 1995; Strauss and Quinn 1997). In fact, cultural models' theoretical foundation is grounded in schema theory. Some cognitive anthropologists use "cultural schemas" and "cultural models" synonymously; others refer to "cultural models" as conceptually complex cultural schemas (D'Andrade 1995; Quinn 1997; Strauss and Quinn 1997). I adopt the latter usage. As conceptually complex cultural schemas, cultural models "connect and organize an interrelated set of elements and hence not only delineate but serve as working models for entire domains of activity in the world" (Quinn 1997:140). However, there are no clear and absolute criteria to delineate the differences between cultural schemas and cultural models.

A Cognitive Approach to Culture

Earlier I spoke of "culture" in various cognitive contexts. What is now needed is a more formal cognitive definition of culture: culture is an individual's shared schemas that are acquired through shared, humanly mediated experiences, as well as the publicly observable human objects, events, and learned practices from which these schemas are derived (D'Andrade 1995; Quinn 2005b, c; Strauss and Quinn 1997). Strauss and Quinn (1997:7) contend that:

> Culture . . . is . . . not some free-floating abstract entity; rather, it consists of regular occurrences in the humanly created world, in the schemas people share as a result of these, and in the interactions between these schemas and this world. When we speak of culture, then, we do so only to summarize such regularities.

In the above passage, Strauss and Quinn (1997) make the case that culture exists in the patterns produced by our socially constructed world, in the shared schemas that we acquire as a result of our experience living in the world, and in the interpretations we derive from the interaction between our shared schemas and the objects and events we encounter in our world. A central focus then of a cognitive understanding of culture is people's more or less shared experiences, the schemas they acquire from those experiences, and the meaning they obtain when their experiences activate their schemas (ibid.).

Shared Experiences

According to Strauss and Quinn (1997:7): "To the extent people have recurring, common experiences--experiences mediated by humanly created products and learned practices that lead them to develop a set of similar schemas--it makes sense to say they share a culture." Our social world is constructed to facilitate shared experiences. For example, common language, child-rearing practices, education, and the built environment offer the opportunity for people to acquire shared experiences (Quinn 2005b, c). It is important to note, however, that it is not the experiences *per se* that are most influential in shaping culture, but the similar general patterns that we interpret from them (Strauss and Quinn 1997). Strauss and Quinn (1997:123-124) expand on this point in their discussion of modal patterning:

> Much of the world is organized in exactly such a way as to ensure that people in the same social environment will indeed experience many of the same typical patterns. This modal patterning is broadly characteristic of human social life, a requirement of many of the practices by which people interact with each other, share knowledge, coordinate common activities, collaborate in common ventures, play the established roles expected of them, and otherwise conform to the laws of their government and the conventions and values of their fellows, as well as model and explicitly teach these common laws and values to others.

Moreover, it is not necessary for individuals to have the exact same experiences to obtain similar general patterns. Individuals can acquire similar general patterns from relatively comparable experiences, but it is also likely that they will experience the same general patterns under different circumstances.

This is possible because salient cultural knowledge is often broadly applied across different contexts and is widely distributed in various cultural forms so that most people within a cultural system will have the opportunity to frequently encounter them (Strauss and Quinn 1997).

The fact that similar general patterns can be experienced in different settings is important in recognizing that cultures are not bounded and separable. Shared cultures (or subcultures) do not only belong to spatially and temporally contiguous communities (Strauss and Quinn 1997). People can share patterned experiences, if only partially and never identical, across space and time. "This makes each person a junction point for an infinite number of partially overlapping cultures" (ibid.:7). As Strauss and Quinn (1997:7), quoting Dan Sperber (1985a), conclude: "There exists . . . no threshold, no boundary with cultural representations on one side, and individual ones on the other. Representations are more or less widely and lastingly distributed, and hence more or less cultural."

They add that this recognition is essential in understanding how, in a complex world, cultural schemas and meanings can have both "centripetal" and "centrifugal" tendencies in social life and not be contradictory (Strauss and Quinn 1997:4, 85). Strauss and Quinn (1997:85) define the centripetal tendencies of cultural understandings in the following way: 1) "they can be relatively durable in individuals"; 2) "[they] can have emotional and motivational force, prompting those who hold them to act upon them"; 3) "they can be relatively durable historically, being reproduced from generation to generation"; 4) "they can be relatively thematic, in the sense that certain understandings may be repeatedly applied in a wide variety of contexts"; and 5) "they can be more or less widely shared . . . in a social group." In contrast, Strauss and Quinn (ibid.) describe the centrifugal tendencies of cultural understandings in this manner: 1) "[they] can be changeable in persons and across generations"; 2) "they can be unmotivating"; 3) "they can be contextually limited"; and 4) "they can be shared by relatively few in a society."

One of the strengths of a cultural-models approach is its ability to demonstrate through theory and data-collection and -analysis methods how cultural models, schemas, and meanings can have both centripetal and centrifugal properties without invalidating one or the other.

Connectionist Model of Cognition

Schema theory has been greatly aided by new ways of modeling how people build up schemas and use them to interpret meaning from their experiences (D'Andrade 1995; Strauss and Quinn 1997). One such model--connectionism or parallel distributed processing--has gained considerable prominence. According to Strauss and Quinn (1997:51), "[connectionism] gives us a productive way to begin the process of rethinking what meanings are and how they arise." As such, it is a useful heuristic to illustrate how schemas are constructed and how meaning arises from them. Moreover, connectionism is a psychological theory of how schemas give rise to meanings that are relatively stable, shared, and consistent in a society (have centripetal properties), as well as variable (i.e., changes with context and through time), differentially distributed, and sometimes inconsistent (have centrifugal properties; D'Andrade 1995; Strauss and Quinn 1997).

There are a number of ways cognitive scientists have thought about the knowledge in our heads; two ways are through "language" and "neural" metaphors (D'Andrade 1995; Strauss and Quinn 1997). The former has been the province of "serial symbolic processing" modelers and the latter has been associated with connectionist modelers (my primary focus). The language metaphor suggests that when we learn something we inscribe that knowledge into our brains in sentences. The brain stores this information using its own symbols and syntax. According to Strauss and Quinn (1997:51), "applying this knowledge is a process of drawing logical inferences or satisfying if-then rules; and revising this knowledge means deleting or amending old propositions."

In stark contrast, the connectionist's neural metaphor suggests that "we think of knowledge not as sets of sentences but as implicit in the network of links among many simple processing units that work like neurons" (Strauss and Quinn 1997:51). Connectionist models have received greater notoriety and support than serial symbolic processing in part because they are thought to best approximate actual human cognition (D'Andrade 1995). Strauss and Quinn (1997:52) describe some of the key aspects of a connectionist model:

> In these models, knowledge is . . . represented by . . . simple processing units arranged in layers (input, output, and one or more layers in between). Aside from units in the input layer, which are

> activated by (computer-simulated or actual recorded) experiences, each unit simply sums the positive and negative signals it receives from other units and passes on a weighted positive or negative total to the other units with which it is connected. . . . The weights on connections between units are modified through repeated exposure to examples of associations that need to be learned. Typically, many units will be working in parallel until some units in the output layer are excited past their threshold and a stable answer is reached. No single unit knows much, but the combined action of many of them, linked by weights modified by repeated experience, leads to intelligent outcomes. Finally each particular connectionist model consists of a group of units that participate jointly in responding to a related set of inputs.

In this connectionist framework, a schema is really a “pattern of interaction among strongly interconnected units” (Strauss and Quinn 1997:52). Some schemas will be more durable than others “depending on the strength and density of the interconnections among the units of which they are composed” (ibid.). Durability comes through the repetition of similar experiences which gradually strengthens the weights of association among schema units.

In a connectionist model, new knowledge is processed by “changing [the] connection weights that shift the likelihoods of what units will activate which” (Strauss and Quinn 1997:53). This demonstrates the ability of schemas to readily process new information. In addition, connectionist models show how schemas can be highly context specific because they are comprised of multiple interlinked networks whose simultaneous operation allows them to address variation. Furthermore, connectionist models illustrate how schemas can be both well-learned and flexibly adaptive. For example, following Bourdieu, Strauss and Quinn (1997:53-54) note that connectionist schemas can adapt to new or ambiguous situations with "regulated improvisation": "The reactions that are the output of connectionist networks are improvisational because they are created on the spot, but regulated because they are guided by previously learned patterns of associations; they are not improvised out of thin air."

Even though connectionist models demonstrate how schemas can readily accommodate and adapt to new knowledge, they also show how schema stability can be self-reinforcing and -confirming through their existence over time. Over the course of an individual's development, schemas can become increasingly well established through their repeated activation. In this instance, schemas become more likely to frame subsequent experiences than be altered by them (Strauss and Quinn 1997). Similarly, Strauss and Quinn (1997:119) add that interpretations of new experiences are likely to be couched in those features that most closely resemble those from previous recurring experiences: "New experiences evoke an interpretation based on overall similarity of features of the current experience to repeated or particularly memorable combinations of features of previous experiences."

D'Andrade (1995) and Strauss and Quinn (1997) argue, however, that connectionism alone does not explain how cultural meanings arise in individuals. They suggest that we also need to understand how social practices and psychological processes influence meaning creation. In particular, they contend that knowledge of the role that emotion and motivation play in schema development and use is fundamental to understanding how meaning is constructed. The follow sections will further explore these issues.

Internalization and Its Affect on Meaning

Cultural models and schemas are not just comprised of learned patterned representations of experience, they also include emotional states that are linked to experience. As Strauss (1992:14; emphasis in original) explains, "life experiences are remembered along with *feelings* associated with them." Cognitive theory suggests that schemas linked to emotional states acquire emotional force that plays an important role in making schemas durable and motivational (D'Andrade 1995; Strauss and Quinn 1997). Moreover, D'Andrade (1995:241-242) adds that unless our schemas acquire emotional and motivational force, or are linked to those with this force, they have little meaning or value in our lives:

> Just as our personalities are partially created by cultural representations, it is the capacity to feel and desire that gives these representations life. Unless they are internalized in the emotional or motivational system of individuals, cultural schemas are nothing more than clichés and dead tropes. Even the ordinary, instrumental aspects of culture--how to spell cat, how to dig a well, how to greet a stranger, etc.--are maintained only because they are linked to goals and emotions that insure their continued use.

Important in the previous passage is the notion of "internalization," which refers to the psychological effects of experience (Strauss and Quinn 1997). In other words, "internalization" may be thought of as the influence that psychological processes--those that underlie the social practices through which schemas are learned and are linked to emotion and motivation--have on schema composition. A distinction can be made between those schemas that have been imbued with more or less emotional or motivational force as a result of how they were learned. By focusing on the process through which schemas are internalized, one is better able to understand why some schemas are more or less durable and motivational.

It is important to note that schemas can be internalized differently. D'Andrade (1992, 1995), referencing Spiro (1987b), describes how people can internalize their schemas on four different levels, producing varying amounts of emotional and motivational force associated with each level. At the first level of internalization, a person is familiar with particular cultural understandings but he does not subscribe to them. "Essentially, the person is indifferent to, or may even reject, the beliefs" (D'Andrade 1992:36 quoting Spiro 1987b). Thus, the understandings hold no emotional or motivational force. At the second level, "cultural beliefs are acquired as clichés--the person 'honors' the directive force of the model 'more in the breach than the observance'" (ibid.). When cultural understandings are acquired at this level, they are "spurious" (ibid.) and again have little or no emotional or motivational force. At the third level, however, cultural understandings become part of a person's own belief system and are held to be "true, correct, or right" (D'Andrade 1995:228). D'Andrade (ibid.) adds that these cultural understandings are linked to emotional feelings and "structure the behavioral environment of social actors and guide their actions." As a result, these understandings are said to be internalized and acquire some degree of emotional and motivational force. Finally, at the fourth level, cultural understandings are internalized and become a part of one's understanding of oneself, and as a result acquire considerable emotional and motivational force (D'Andrade 1992, 1995). According to D'Andrade (1995:228; emphasis in original), actors hold these understandings with strong conviction and they "not only guide but *instigate* action, and the entire system is invested with emotion." In terms of being "invested with emotion," D'Andrade (ibid.; emphasis in original) explains that "individuals experience the truth and rightness of certain ideas as emotions *within* themselves."

D'Andrade's (1992, 1995) discussion of Spiro's four levels of internalization posits that schemas that are associated with considerable emotional and motivational force become indistinguishable from the "self." This belief draws on a related view of internalization as "the process by which cultural representations become a part of the individual; that is, become what is right and true" (D'Andrade 1995:227), as well as natural (D'Andrade 1995; Quinn 1992). Here, internalization refers to an ultimate state where schemas become identified as aspects of one's personality and part of one's personal beliefs--including one's understanding of life and place in it--through linkages to emotion and motivation (D'Andrade 1995; Quinn and Holland 1987). Thus, cultural models and schemas that supply individuals with understandings of themselves and their worlds in a way that seems right and natural are likely to be compelling and have motivational force (Quinn 1992; Quinn and Holland 1987). Quinn and Holland (1987) argue that these understandings are vital because they provide the most general source of guidance, orientation, and direction in our lives.

Motivation, Goals, and Behavior

> To understand people one needs to understand what leads them to act as they do, and to understand what leads them to act as they do one needs to know their goals, and to understand their goals one must understand their overall interpretive system, part of which constitutes and interrelates these goals, and to understand their interpretive system--their schemas--one must understand something about the hierarchical relations among these schemas (D'Andrade 1992:31).

A general understanding in cognitive anthropology is that cultural schemas affect human action through linkages with emotion and motivation (D'Andrade 1995). According to D'Andrade (1992, 1995), motives can range from things like thirst, hunger, and pain, which result from internal (biological) stimulus, to self-esteem, aggression, and achievement needs, whose stimuli are more difficult to identify. One way cognitive scientists have resolved the burden of identifying motives with stimuli is by defining them as goals. Motives defined as goals are ones that have some degree of autonomy. In other words, D'Andrade (1995:229) suggests that "if someone pursues a goal for its own sake, that goal can be taken to represent a motive."

The understanding of motives as goals is central to cognitive anthropologists' contention that some cognitive schemas function as goals for individuals, and thus have motivational force. These "goal-schemas" are more than recognition devices; they instigate action (D'Andrade 1992, 1995). Also, it is important to note that while some schemas do not function as goals, all goals are schemas. D'Andrade (1992) explains that goals cannot activate themselves; they are reliant on the activation of cognitive structures to which they are linked for interpretations that instigate the action needed to achieve them.

As suggested, goal autonomy is related to motivational force. Thus, the extent to which schemas function as goals imbued with motivational force rests on their ability to instigate action relatively autonomously. The reality, however, is that the autonomous nature of schemas widely varies. Fewer schemas act as autonomous goals, and a larger number serve as partial goals in that they only become goals when linked to or recruited by goal-schemas (D'Andrade 1992).

Motivational force plays a role in the hierarchical relationships that schemas form in the process of creating meaning (D'Andrade 1992, 1995). In this hierarchical system, lower-level schemas pass on interpretations to higher-level ones (if linked) until a final interpretation of an experience or thought is derived. And if the final interpretation activates top-level schemas (which tend to be goals), whose primary role is to determine action, motivation to take action is provided. D'Andrade (1992:30) concludes that since top-level schemas are the final arbiters of meaning and action, "a person's most general interpretations [derived from top-level schemas] of what is going on will function as important goals for that person." D'Andrade (1992, 1995) refers to these top-level schemas (e.g., love, security) as master motives that function as a person's most general goals, instigating action relatively autonomously. Strauss (1992:3) adds that high-level goal-schemas "are easily triggered by a wide range of inputs," linking them to many lower-level schemas. Next are middle-range schemas (e.g., marriage, work) that also contain potent goals, but are usually not fully autonomous and need to be recruited by higher-level goal-schemas that "'guide,' 'orient,' and 'direct' the flow of action" (Quinn and Holland 1987:12-13). Finally, at the bottom of the schema hierarchy is low-level schemas (e.g., writing memos, standing in lines) that usually have no motivational force and are dependent on higher-level goal-schemas to activate them (D'Andrade 1992, 1995). Thus, lower-level schemas only direct action if they are recruited by higher-level goal-schemas (Strauss 1992).

Self-Understandings and Perceptions of What Is Natural and Right

Quinn (1992) and Quinn and Holland (1987) argue that cultural models and schemas become high-level goal-schemas imbued with motivational force because they supply people with understandings of themselves or are viewed as objectives (both natural and right) that are valued in their own right. In an example of the former, some individuals are motivated by achievement. According to Quinn (1992:91), this motivation does not stem from some abstract belief a person has about the merits of achievement, "but out of an abiding inner sense that he would be less of the person he wants to be should he not attain the high standards he has set himself, or at least make every effort to do so." Thus, this sense of self (or self-understanding) serves as a high-level goal-schema because it is so close to the core of his being "and casts [him] as a natural being and a moral actor" (ibid.:118). Quinn contends that the reason why self-understandings are so important to us and define our most general goals rests on how we come to know ourselves through our experiences. She refers to this internalizing act as: "The process by which cultural schemas are incorporated into a sense of 'self,' thereby entering into the definition of an individual's existential concerns and life ambitions" (ibid.:91-92).

Moreover, D'Andrade (1995), Holland (1992), and Quinn (1992) argue that identification with cultural models and schemas plays an important role in their development of motivational force. Holland (1992) adds to this that involvement and identification with certain cultural models and schemas can simultaneously develop in relation to one another as individuals gain a sense of expertise in them, which in turn increases their motivational force.

In addition, Quinn (1992) notes that childhood and adolescent experiences are particularly influential in the shaping of self-understandings, and that these self-understandings can acquire considerable motivational force as a result of the socialization process through which they are learned. She also suggests that the extent to which self-understandings acquire motivational force depends in part on their perceived naturalness and rightness, which is learned in the course of socialization (ibid.). Quinn (1992:92) adds that the link between motivational force and the "naturalness" and "rightness" of self-understandings has to do with how the former are experienced as "needs or obligations to do something." The idea is that because needs are inherently human and obligations are morally ordained, their fulfillment is natural, right, and necessary (ibid.). Thus, self-understandings acquire motivational force because individuals are socialized to perceive them as an inherent part of their existence. D'Andrade (1995:228), quoting Gerber's (1985) work in Samoa, notes how Samoans are motivated to assist their elders because they are socialized to believe that doing so is moral and natural, and thus a normal part of one's sense of self: "A Samoan gives, therefore, not only because he or she has been trained to view giving as morally correct but also because his or her training has created a disposition to feel such an act as 'natural,' seeming to rise out of the very depths of his or her being."

Furthermore, when a practice like "giving aid" (i.e., a cultural model or schema) is learned along with certain emotional states, the practice may evoke the physical experience of the feelings linked to it, enhancing its motivational force. As D'Andrade (1995:229) explains: "This cultural shaping of the emotions gives certain cultural representations emotional *force*, in that individuals experience the truth and rightness of certain ideas as emotions within themselves--as something internal to themselves." Thus, referencing Gerber again, D'Andrade (ibid.) adds that a Samoan's "moral dictates to be obedient and dutiful are experienced (sometimes) as a loving feeling."

In addition, Quinn and Holland (1987:11) suggest that cultural models and schemas that embed a view of "'what is' and 'what it means' that seems wholly natural--a matter of course"--are also likely to acquire motivational force. In other words, D'Andrade (1995:235), drawing on Shweder, explains that "the motivational force of some goals can be a simple result of what people understand to be the realistic facts of life." In this instance, "schemas are experienced not as models of reality, but as reality itself" (D'Andrade 1992:38). And the undeniable reality of these schemas gives them motivational force.

Quinn and Holland (1987) note that in addition to the naturalness of these cultural models and schemas, they also impart a sense of necessity to how we live our lives that imbue them with directive force. This force can be explained in part by our desire to pursue what we consider the "typical and normal way of life," in which we find confirmation from observations of others in our community who we believe share similar lifeways with us. Most often, however, Quinn and Holland (1987:11), referencing D'Andrade and Spiro, suggest that some cultural models are motivating because their activation "directly satisfies some culturally defined need . . . or realizes some strongly held cultural norm or value."

D'Andrade (1995) and Strauss and Quinn (1997) also refer to this directive force as experiences that engender the need or obligation to do something. And it is through socialization that individuals learn to associate certain emotional states with attempts to meet needs and obligations (i.e., moral or proper behavior), and these feeling-states motivate their pursuit. Quinn and

Holland (1987:11), quoting D'Andrade (1984a), explain it this way: "Through the process of socialization individuals come to find achieving culturally prescribed goals and following cultural directives to be motivationally satisfying, and to find not achieving culturally prescribed goals and not following cultural directives to be anxiety producing."

The Effect of Socialization on Cultural Models and Schemas

I have suggested that socialization practices and their psychological effects play an important role in the durability and motivational force of cultural models and schemas. In this section I provide a more formal discussion of this important learning process. Schemas become durable and acquire motivational force because they are internalized with emotion. According to Strauss and Quinn (1997:92-93), "emotional arousal during or immediately after an experience . . . strengthens the neural connections that result from that experience." Thus, an emotive response to a particular experience can alter "the neurochemical environment in which relations among features [to that] experience were internalized" (ibid.), making a person's schemas more salient than they would be if little feeling were associated with the observation. Each time a previously emotion-laden experience presents itself, the emotion may reappear and "heighten the effect of the incident and the strength of the associations [a person] brings away from it" (ibid.). According to Strauss and

Quinn (1997:92-93), “the resulting schema becomes still stronger and even more likely to be activated in the future, at the expense of alternative understandings.”

The internalization of emotions, then, not only plays a key role in making cultural schemas durable, but the inner experience of feelings (resulting from their internalization) mediates motivations and significantly contributes to cultural schemas’ motivational force (Strauss and Quinn 1997). Moreover, the linking of emotions with schemas makes cultural representations a part of the self and gives them the emotional and motivational force necessary to make certain understandings durable and to instigate action.

Socialization practices that have considerable influence over the durability and motivational force of cultural schemas are those where socializers formally or informally, consciously or unconsciously, mete out rewards and punishments for certain behaviors, convey evaluations of the learner’s “goodness” or “badness,” and give or withhold affection (Strauss and Quinn 1997). In terms of rewards and punishments, praise and scare tactics can make learning durable and motivating by not only influencing immediate behavior but by creating such a strong emotional feeling with the experience that similar behaviors in the future are likely to be reproduced. Over time, Strauss and Quinn (1997) note that the feelings of praise and fright can be self-administered, recreating the emotions that lead one to pursue or abandon certain behaviors.

Social evaluations are another mechanism that make the acquisition of cultural schemas more or less durable and motivational (Strauss and Quinn 1997).

Social evaluations can be thought of as ideas about the goodness or badness of behavior (e.g., being a good or bad Christian, a normal or abnormal person, a real man or not). When ideas about the goodness or badness of one's behavior--and that of others--are learned in association with emotional states engendered by their approval and disapproval, then the linked feelings play a powerful role in the durability and motivational force of the social evaluation. As Strauss and Quinn (1997:95) explain: "Once learned in association with given ideas of good and bad behavior, the emotions themselves--even in the absence of real or fantasized social approval or disapproval or other rewards or punishments attendant on these--motivate the good behavior and inhibit the bad, just as other positive and negative emotions can motivate behavior with which they have become associated."

Also, if social evaluations are learned in association with feelings of being loved, or having love withdrawn, for one's good or bad behavior, the cultural schemas derived from the experience will be durable and imbued with motivational force (Strauss and Quinn 1997). Strauss and Quinn (1997) add that social evaluations of the self are particularly durable and motivational because individuals want to feel like a good person, rather than a bad one. In their words: "To the extent that evaluations become aspects of self identity, they can act as very stable goals for which people strive throughout their lives in order to remain true to their self images. These goals are stable and powerful enough to prevent people from drifting into other patterns of behavior that would be easier accommodations to practical obstacles" (ibid.:96).

Finally, it is important to note that childhood and adolescent socialization experiences are particularly influential in shaping the durability and emotional and motivational force of cultural schemas (D'Andrade 1995; Quinn 1992; Strauss and Quinn 1997). Quinn (1992) and Strauss and Quinn (1997) explain that early experiences are linked to strong feelings of survival and security. And the extent to which children learn to associate ideas about themselves, others, and their relationship to the world with these strong feelings, they will have a powerful and lasting effect on motivation and learning. Strauss and Quinn (1997) contend that this is particularly true for feelings linked to ideas about being good and bad.

D'Andrade (1992) and Strauss and Quinn (1997) add that parents, teachers, and other primary socializers draw on evaluative discourses that activate children's strong emotional feelings as part of the learning process. The effect is that children learn to associate these strong feelings with certain ideas and behaviors--cultural models or schemas--making them indelible and motivational and powerful influential forces in later life. As Strauss (1992:12) explains, "Regularities learned early in life set up expectations that affect the way we interpret later experience."

Moreover, Quinn (1992:121) argues that cultural models and schemas "have the potential for motivational force because they are simultaneously structures for adult understanding and vehicles of child socialization." In short, Quinn (ibid.) purports that we are socialized as children to honor certain ideas as a part of who we are, and that these early socialization efforts are successful because socializers cultivate these shared ideas as right and natural.

> When particular ideas about human relations, about role obligations, or about types of people have force for us, rather than just being possible interpretations of the social world, it is because as children and young adults we have been socialized by means of appeals to these very ideas. We have been taught that this is our role, our nature, the way we should be treated and treat other people. I want to argue that these more or less explicit messages from socializing agents, and these lessons extracted from the behavior modeled by these socializers, are effective precisely because they depend upon cultural assumptions about what is moral and what is natural (Quinn 1992:121).

Cognitive Theory and Cultural Models

In subsequent chapters I will return to this discussion of cultural models and schemas to frame and illustrate my research methods and findings. For example, in Chapter 4, I describe the influence of cognitive theory and method in my collection and analysis of dissertation data. Then, in Chapter 6, I draw on my discussion of cultural models and schemas to identify and construct (from ethnographic data) farmers' cultural model for grain-farm management. Finally, in Chapters 7-9, I further draw on the cognitive theory presented in this chapter to highlight the durability and motivational force of farmers' cultural model for grain-farm management, as well as its policy relevance.

Chapter 3

Study Area and Population

Figure 3.1. Chesapeake Bay Watershed and Surrounding Area (Weinberg 2008).

My dissertation is based on research conducted in the Chesapeake Bay watershed (see Figure 3.1 above). More specifically, my work focused on a geographic area of the watershed called "Delmarva," which is short for Delmarva Peninsula (see Figure 3.2 below). The Delmarva region includes parts of Delaware, Maryland, and Virginia, hence its name.

Figure 3.2. Delmarva Peninsula (Denver et al. 2004).

Within Delmarva, my research activities were concentrated in the Lower Eastern Shore (LES) of Maryland, which is comprised of Somerset, Wicomico, and Worcester Counties (see Figure 3.3 below). The LES is the southernmost part of a nine-county area called Maryland's Eastern Shore (ES).

Figure 3.3. Maryland Eastern Shore Counties and Lower Eastern Shore Study Area (Weinberg 2008).

Maryland's ES is bordered by the Chesapeake Bay to the west and Delaware and the Atlantic Ocean to the east, and is separated from the rest of Maryland by the four-mile-long Chesapeake Bay Bridge (see Figure 3.2). Until the bridge's construction in 1952 (MTA 2008), the ES remained relatively isolated from mainland Maryland.

Chesapeake Bay

The Chesapeake Bay and its watershed are both significant ecological resources and a central focus of and testing ground for national efforts to maintain and restore sensitive natural resources. As an ecological resource, the bay is the largest estuary in North America (4,480 square miles and 11,684 shoreline miles) and one of the most productive in the world. It supports more than 3,600 species of plants, fish, and animals; produces 500 million pounds of seafood per year; and is a commercial and recreational resource for more than 16 million people who reside in its basin. In addition, the bay watershed encompasses 64,000 square miles, stretching across six states (New York, Pennsylvania, Maryland, Delaware, Virginia, and West Virginia) and the District of Columbia, all of which drain into the bay and its tributaries (see Figure 3.1; CBP 2008b).

Population and Land Use of the Eastern Shore and Lower Eastern Shore

According to the 2000 census, the ES is a sparsely populated area of 395,903 individuals on 3,324 square miles. This represents 7 percent of Maryland's total population and 34 percent of its land area. In turn, the LES has a population of 155,934 individuals on 1,178 square miles. This comprises 39 percent of the ES population and 35 percent of its land area (MSDC 2002a, b, c, d, e, f, g, h, i, j; U.S. Census Bureau 2008a, b, c, d, e, f, g, h, i, j).

Table 3.1. LES, ES, and Md. Population and Land Area in 2000.

	Population	Land Area (square miles)
Lower Eastern Shore	155,934	1,178
Eastern Shore	395,903	3,324
Maryland	5,296,486	9,774

Source: (MSDC 2002a, b, c, d, e, f, g, h, i, j; U.S. Census Bureau 2008a, b, c, d, e, f, g, h, i, j).

Major population centers on the LES range from Salisbury at 24,159 individuals, to Ocean City at 7,184, to Pocomoke City at 4,066, to five other towns with populations between 2,300 and 3,800 people (Princess Anne, Snow Hill, Crisfield, Berlin, and Fruitland; MDNR 2007a; MSDC 2002b, c, d; TCC 2007).

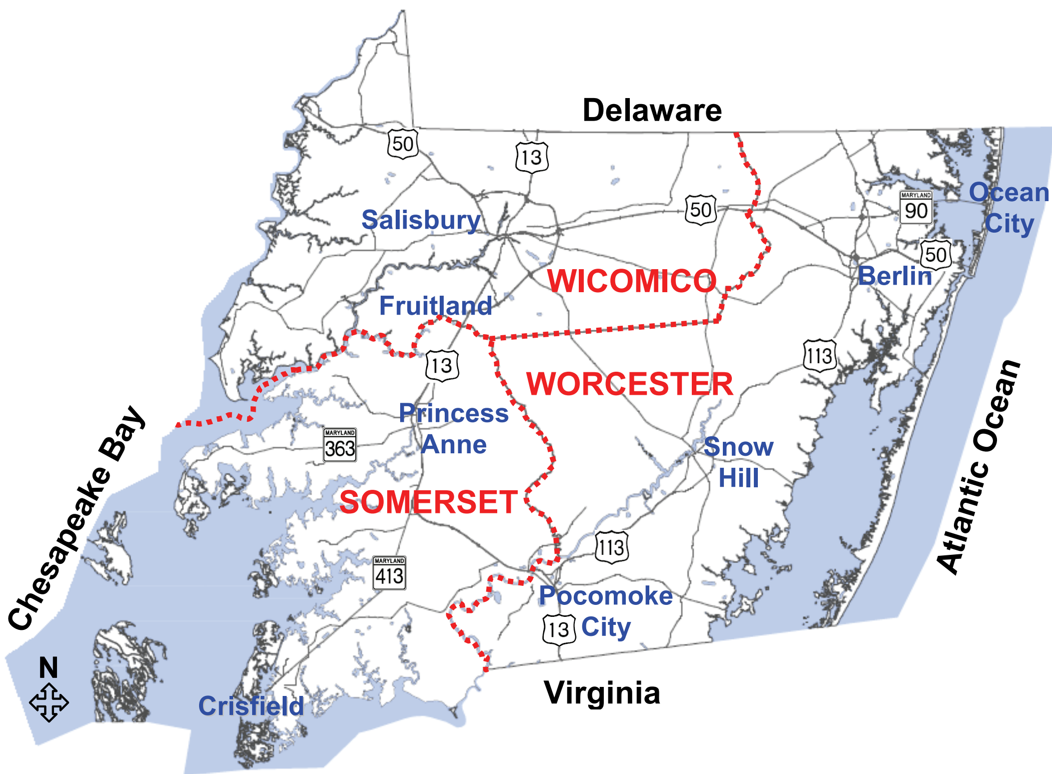

Figure 3.4. Major Population Centers on Maryland's Lower Eastern Shore (MDP n.d.).

Maryland has divided the ES into three subwatersheds or basins through which land cover descriptions are provided (see Figure 3.5 below). These subwatersheds include the Lower Eastern Shore Basin (LESB), Choptank River Basin (CRB), and the Upper Eastern Shore Basin (UESB). Subwatershed boundary determinations are based on water drainage areas and not geopolitical boundaries, so the ES's three basins roughly approximate ES and LES land cover by county.

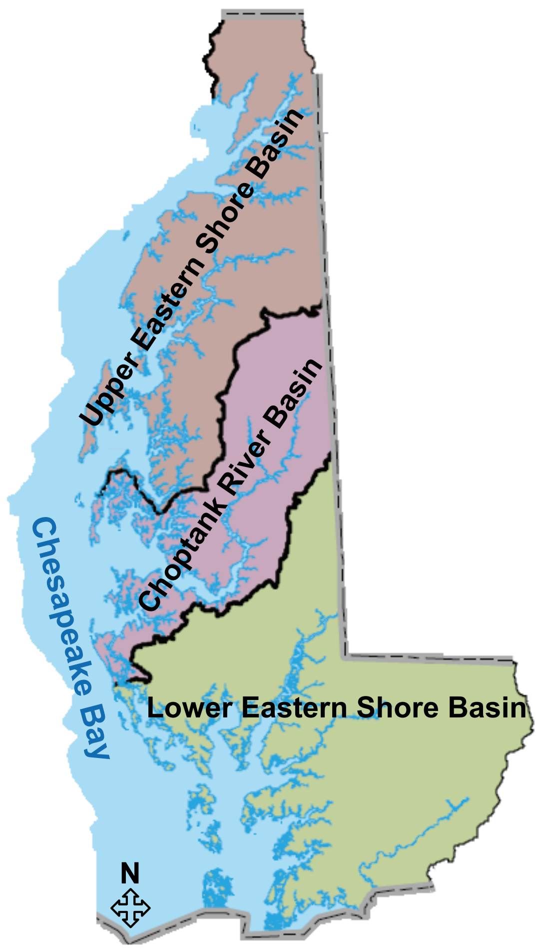

Figure 3.5. Maryland's Eastern Shore Tributary Subwatersheds (Andrews 2008).

In general, agricultural, forest, and wetland lands largely comprise ES land use (see Table 3.2 below). As illustrated by LESB land use, the LES study area is mostly agricultural (33%) and forest (45%) land. Wetland (15%) and urban (7%) land areas make up the remainder of other significant land uses (MDNR 2007a). In addition, a separate report reflecting wetland cover for the three LES counties indicates that 23 percent of their acres are wetlands, which make up nearly 30 percent of all state wetlands (TCC 2007).

Table 3.2. ES Land Use by Subwatersheds.

	Agriculture	**Forest**	**Wetland**	**Urban**
Upper Eastern Shore Basin	58%	29% Combined		7%
Choptank River Basin	58	29	Not listed	10
Lower Eastern Shore Basin	33	45	15	7

Source: (MDNR 2007a, b, c).

General Demographic Characteristics for the Lower Eastern Shore

The Lower Eastern Shore population in 2000 was about 156,000 people (MSDC 2002b, c, d). Of this total, approximately 49 percent were male, 73 percent were white, and 24 percent were African American. In terms of educational attainment (25 years and over) in 2000, 21 percent did not obtain a high school degree, 35 percent did, 13 percent received a bachelors degree, and 7 percent obtained a graduate or professional degree (MSDC 2002a, b, c, d; U.S. Census Bureau 2002).

Looking at LES income, per capita income in 1999 was $15,965 in Somerset County, $19,171 in Wicomico County, and $22,505 in Worcester

County. By comparison, Maryland's per capita income was $25,614, while the U.S.'s was $21,587. In addition, 12.8 percent of LES residents lived below the poverty level in 1999, and 6.5 percent of the LES civilian labor force was unemployed in 2000 (MSDC 2002a, b, c, d; U.S. Census Bureau 2002).

Eastern Shore and Lower Eastern Shore Economy

Tourism

As is the case for the larger Eastern Shore and Delmarva Peninsula, the LES economy is driven by agricultural production, poultry processing, and tourism (TCC 2007). Tourism in Maryland generated more than $11 billion in visitor spending in 2006. Of that total, Worcester County (one of three LES counties) alone had close to $1.3 billion in visitor spending. This made it the fourth highest ranking Maryland county for tourism spending, comprising 11.3 percent of the state total. In general, tourism on the LES accounted for 17,000 jobs (81% of tourism jobs on the ES) and close to $400 million in payroll (80% of ES tourism payroll). Just in Worcester County, which has significant tourism trade in the Ocean City beach community, tourism-related employment provided more than 55 percent of all jobs. Studies suggest that more than 40 percent of Maryland travelers visit either Ocean City or Baltimore (MOTD 2008; TIA 2007).

Agriculture

Agriculture is Maryland's largest commercial industry (ACP 2008). According to Gardner et al. (2002:x): "The farming sector and its related industries (e.g., agricultural inputs and services and food processing) accounted for about $5 billion (3%) of the Maryland gross state product in 1999 and employed 62,700 people (12,400 farm operators, 5,900 farm laborers, and 44,300 in farm input and service supply and agricultural processing)." Agriculture is particularly important for the ES. Even though 2002 agricultural census data indicate that the ES comprises only 29 percent (n=12,198) of Maryland farms and about 5 percent of the Chesapeake Bay watershed, its 972,353 farm acres (47% of state farm acres) contain the highest concentration of grain and poultry production in the bay watershed. In addition, ES agriculture accounted for 66 percent (~$848.5 million) of the value of all Maryland agricultural products sold in 2002 (NASS 2004a; Sims and Coale 2002; Staver and Brinsfield 2001).

Among the ES counties, the LES has the highest concentration of grain and poultry production (Sims and Coale 2002; Staver and Brinsfield 2001). The LES's 1,216 farms (34% of ES farms) on 276,369 acres (28% of ES farm acres) accounted for 50 percent (~$425.3 million) of the value of all ES agricultural products sold in 2002 (NASS 2004a).

The ES's high agricultural production value is largely attributed to the poultry industry on the Delmarva Peninsula. Three nationally ranked poultry companies are headquartered on Delmarva, and another has extensive operations in the area (see Table 3.3 below). Perdue Farms is headquartered on the LES and has extensive facilities there (e.g., processing plants, hatcheries, feed mills). The other poultry companies also have facilities in Maryland, as well as in Delaware and the eastern shore of Virginia. On the LES alone, a 2004 poultry industry fact sheet indicated that there are eight hatcheries, six feed mills, and three processing plants (DPI 2004).

Table 3.3. Delmarva Poultry Company Headquarters and Rankings.

	Headquarters	**National Rank**
Allen Family Foods	Seaford, Del.	15
Mountaire Farms	Selbyville, Del.	6
Perdue Farms	Salisbury, Md.	3
Tyson Foods	Springdale, Ark.	2

Source: (DPI 2008).

In another example of the scale of the Delmarva poultry industry, integrators (i.e., poultry companies) reported close to 15,000 company employees in 2007 and a payroll of about $386 million. In addition, in 2007, Delmarva's estimated 1,900 poultry growers in 5,300 poultry houses produced about 566 million birds. These birds weighed 3.4 billion pounds and had a wholesale value of $1.9 billion (DPI 2008). Maryland (almost solely the ES) produced about half of the birds grown on Delmarva in 2007 and ranked eighth in number of broilers and ninth in pounds of broilers produced among all states. Figures were not available for 2007, but in 2006, Maryland ranked tenth among all states in broiler production value ($535 million), and Delaware ranked seventh ($740 million). Given the high production value of poultry in Maryland, about 33 percent of

Maryland's cash farm income was from broilers in 2006. In addition, almost all of the ES's corn and soybeans are sold to the poultry industry for use as chicken feed. For example, ES farmers sold approximately 18.4 million bushels of corn and 6.6 million bushels of soybeans to the Delmarva poultry industry in 2002 (DPI 2008; NASS 2004a).

According to the 2002 agricultural census, the three LES counties led the state in poultry production and had the highest market value of agricultural products sold among all Maryland counties. For example, Wicomico (#1), Somerset (#2), and Worcester (#3) were the three leading Maryland counties in the market value of livestock, poultry, and their products sold, as well as in the total market value of all agricultural products sold. At the national level, Wicomico ranked 18th, Worcester 23rd, and Somerset 24th among all U.S. counties in broiler production in 2002. In achieving these rankings, about 500 LES farms (61% of Maryland's meat-producing poultry farms) sold approximately 200 million broilers in 2002 (69% of the total number of Maryland meat-type chickens sold). And the average value per farm of agricultural products sold was $422,848 for Somerset County, $341,003 for Wicomico County, and $306,328 for Worcester County in 2002. These dollar amounts are high given that the average value per farm of agricultural products sold was $106,026 for Maryland and $94,245 for the U.S. in 2002 (DPI 2008; NASS 2004a, b).

In terms of crop, nursery, and greenhouse production, the LES market value in 2002 for these products was about $51.3 million. This amount was approximately 22 percent of the ES value for the same products (~$234 million), and the ES amount was roughly 52 percent of the state value. The primary crops grown on the LES are grain corn, wheat, and soybeans (see Table 3.4 below). For total crop acres harvested, LES counties were among the top 13 Maryland counties for each crop, with Worcester being second in corn acres and fifth in soybean acres. As a result of these harvests, LES farmers produced 18 percent of Maryland's grain corn, 10 percent of its wheat, and 21 percent of its soybeans in 2002 (NASS 2004a).

Table 3.4. LES Grain Corn, Wheat, and Soybean Production in 2002.

	Farms	Acres Grown
Grain corn	344	75,689
Wheat	132	16,482
Soybeans	398	87,842

Source: (NASS 2004a).

General Demographic and Farm Characteristics for LES Farmers

As previously indicated, the LES study area in 2002 was comprised of 1,216 farms on 276,369 acres. The majority of principal farm operators were men (85%), most of whom were white (96%). African American farm operators (3%) were the next largest racial group. In addition, about 6 percent of principal operators were under 35 years of age, 42 percent were 35 to 54, and 52 percent were 55 years of age and older (NASS 2004a).

In terms of LES farm size in 2002 (see Table 3.5 below), about 74 percent were less than 180 acres, 14 percent were 180 to 499 acres, 6 percent were 500 to 999 acres, and another 6 percent were 1,000 acres or more. These size percentages were similar to those found for all Maryland farms. Compared to U.S. farms, they were somewhat larger for farms with fewer acres, and smaller for those with more acres. When looking at average farm size in Table 3.6 below, some of these differences are noticeable (NASS 2004a, b).

Table 3.5. LES, Md., and U.S. Farms by Size in 2002.

	Lower Eastern Shore	Maryland	U.S.
Total farms	1,216	12,198	2,128,982
Farms by size			
1 to 9 acres	13%	12%	8%
10 to 49 acres	35	36	27
50 to 179 acres	26	29	31
180 to 499 acres	14	15	18
500 to 999 acres	6	5	8
≥ 1,000 acres	6	3	8

Source: (NASS 2004a, b).

Table 3.6. Average Size of Farm Acres in 2002.

	Average Farm Size (acres)
Somerset County	188
Wicomico County	173
Worcester County	326
Maryland	170
U.S.	441

Source: (NASS 2004a, b).

In regard to the value of LES farm sales in 2002 (see Table 3.7 below), further differences between LES, state, and national numbers are illuminated. For example, 72 percent of Maryland and U.S. farms had sales values less than

$25,000, while 44 percent (535) of LES farms had the same sales values. In addition, 17 percent of Maryland farms and 14 percent of U.S. farms had sales values of $100,000 or more, which was in sharp contrast to the 48 percent (583) of LES farms with sales in this same category. Two explanations for this higher percentage could be that more LES farmers listed farming as their principal occupation (65%) compared to Maryland (57%) and U.S. (58%) farmers, and that the high sales value of LES poultry production generated greater farm sales than those represented by state and national totals (NASS 2004a, b). Nevertheless, LES farmers' net cash farm income in 2002 averaged $1,964, which was considerably less than Maryland ($9,220) and U.S. ($15,848) averages (ibid.).

Table 3.7. LES, Md., and U.S. Farms by Value of Sales in 2002.

	Lower Eastern Shore	**Maryland**	**U.S.**
Total farms	1,216	12,198	2,128,982
Farms by value of sales			
≤ $2,499	27%	42%	39%
$2,500 to $4,999	4	10	10
$5,000 to $9,999	6	9	11
$10,000 to $24,999	7	11	12
$25,000 to $49,999	4	6	7
$50,000 to $99,999	4	5	7
≥ $100,000	48	17	14

Source: (NASS 2004a, b).

Chapter 4

Research Methods, Fieldwork, and Data Analysis

Research Methods

My data-collection activities closely followed those of cognitive anthropologists conducting similar cultural-models research (D'Andrade 1995; D'Andrade and Strauss 1992; Holland and Quinn 1987; Paolisso 2002; Quinn 2005a; Shore 1996; Strauss and Quinn 1997). In brief, the prototypical qualitative cultural-models approach to data collection uses individual interviews, which are audio-recorded and transcribed, with a relatively small number of interviewees as its primary data-collection mechanism (D'Andrade 2005; Holland and Quinn 1987; Quinn 2005b, c; Strauss and Quinn 1997). This does not imply that data derived from other data-collection tools like participation observation are not important in interpreting cultural understandings. Rather, it is based on the premise that the cultural analysis of talk is a better mechanism to recover or reconstruct shared tacit understandings (D'Andrade 2005; Quinn 2005b, c).

Interviews in cultural-models research are typically conversational in style, and interviewees are encouraged to take some control of the interview process. In other words, using a general topic or set of questions around a topic, the interviewer encourages interviewees to talk at length about their understandings of the topic and to organize their responses in a way that makes the most sense to them. Through prompts, probes, redirection (when necessary), and good listening practices, the interviewer encourages interviewees to fully explain their views and opinions related to the topic and allows them to make off-topic comments they believe are linked to the primary subject of discussion. Interview times may be an hour or more, and multiple interviews with the same people can increase the breadth and nuance of culture knowledge communicated. The idea is to acquire a rich body of relatively uninterrupted talk around a particular topic, which can be used to look for shared explicit and implicit understandings (D'Andrade 2005; Holland and Quinn 1987; Quinn 2005b, c; Strauss and Quinn 1997).

D'Andrade (2005:99) argues that "a sample of 20-30 [interviewees] is sufficient to obtain a reasonable estimate of the degree of agreement for the items of a cultural model." This sampling practice generally reflects those of other cultural-model researchers (D'Andrade 2005; Holland and Quinn 1987; Paolisso 2002; Quinn 2005b, c; Shore 1996; Strauss and Quinn 1997).

In pursuing the data-collection activities just described, I used a snowball approach to solicit farmer participation, and selected potential informants based on a purposive-sample design. This sample design gave me the flexibility to recruit potential informants over time based on their diverse backgrounds, experiences, and interests, as well as their ability to effectively communicate their beliefs and views (Bernard 1995). Also, in the beginning of my research, I used informal and unstructured informational interviews with potential informants to better understand the wide range of topics and issues that surrounded Lower Eastern Shore (LES) farmer understandings of Maryland's nutrient-management efforts (Agar 1980). These informational interviews not only provided valuable knowledge about salient issues of interest and concern to farmers, but also facilitated my snowball approach, helped build rapport with farmers, and gave me the opportunity to select semistructured-interview participants.

Drawing on knowledge obtained from informational interviews, as well as my topical interests in exploring environmental issues, I created a broad list of semistructured-interview questions that I believed would facilitate comprehensive farmer discussions of the cultural elements that compose their views of Maryland's nutrient-management regulations. These questions solicited farmer understandings of a wide range of topics, including: farming and farm life, important agricultural issues and concerns, *Pfiesteria*, nutrient-management regulations, nature, pollution, community, private property, core values and guiding philosophies, natural-resource management, science, environmentalists, and policy makers.

My goal was to conduct semistructured interviews with 25 to 30 LES farmers--and when possible interview some twice--and to audio-record (Maloney and Paolisso 2001) and transcribe these interviews. My hope was that these transcripts would contain a rich body of discourse from which I could identify explicit cultural understandings and interpret the implicit meanings that underlie them on a wide range of issues that informed farmer views of Maryland's nutrient-management policy efforts. My data-collection methods also included the audio-recording and transcription of public hearings where Maryland farmers voiced their concerns about and opposition to Maryland regulations that would require farmers to adhere to state-mandated nutrient-management practices. In addition, while living on Maryland's Lower Eastern Shore and interacting with farmers in public venues and on their farms, I used continuous participant observation as a data-collection tool.

Fieldwork

I conducted research with Maryland farmers during three different periods: June through September 1998, February through March 2000, and July 2000 through July 2001. In the summer of 1998, while living on the LES, I conducted approximately 42 ethnographic interviews with LES farmers: 30 informal and unstructured informational interviews and 12 semistructured interviews. Ten of the 12 semistructured interviews were with farmers who had grain-production knowledge and experience. I took handwritten fieldnotes (some of which were word processed) during all interviews. In addition, I audio-recorded 9 of the 12 semistructured interviews and had them transcribed. Eight were with my grain-farming target group. Semistructured interviews ranged in length from 30 to 120 minutes, but most were a little over 60 minutes.

During the winter of 2000, seven public hearings were held across Maryland to introduce and solicit comments from the general public and agricultural community on the state's nutrient-management regulations. Attendance at these public hearings varied from 50 to 120 attendees. Those in attendance were predominately male and from Maryland's agricultural community (Paolisso and Maloney 2000a). Two hearings were held on Maryland's Eastern Shore (ES), one of which was on the LES. I attended six of the seven public hearings, including the two ES hearings, and audio-recorded the two-to-three-hour events. Each of these recordings was transcribed.

From July 2000 through July 2001, I lived on the LES for several weeks at a time every other month or so and conducted 52 ethnographic interviews with LES farmers: 20 informal and unstructured informational interviews and 32 semistructured interviews. Twenty-seven of the 32 semistructured interviews were with farmers who had grain-production knowledge and experience. As before, I took handwritten fieldnotes (some of which were word processed) during all interviews. In addition, I audio-recorded 31 of the 32 semistructured interviews and had them transcribed. Twenty-six were with my grain-farming target group. Semistructured interviews ranged in length from 45 to 180 minutes, but most were about 90 minutes.

In the winter of 2001, I audio-recorded what came to be known as Maryland's co-permitting hearings. Two of these hearings were held on the LES. In brief, co-permitting would require poultry companies (also known as integrators) to be accountable for their growers' nutrient-management activities. Poultry growers, grain farmers, and agricultural interest groups showed up in large numbers at all three hearings to voice their strong opposition to co-permitting. I attended all three hearings and obtained transcripts of them from Maryland Department of Environment staff. Each hearing was approximately 180 minutes long and gave the opportunity for more than 60 ES poultry growers (many of whom were also grain farmers) to voice their concerns over co-permitting and nutrient-management policies in general.

Table 4.1. Farmer-Interview Statistics.

Interview Type by Number Interviewed (n=78)	
Informal/unstructured interviews	50
Semistructured interviews	28
Grain-farming target group	(23)
Total Semistructured-Interview Counts	
Semistructured interviews	44
Farmers interviewed once	15 (14 transcripts)
Farmers interviewed twice	10 (19 transcripts)
Farmers interviewed three times	3 (7 transcripts)
Semistructured-interview transcripts	40
Grain-Farming Target Group Semistructured-Interview Counts	
Semistructured interviews	37
Farmers interviewed once	12 (12 transcripts)
Farmers interviewed twice	8 (15 transcripts)
Farmers interviewed three times	3 (7 transcripts)
Semistructured-interview transcripts	34

In total, I interviewed 78 different LES farmers (see Table 4.1 above). Of the 78 I interviewed, 50 participated in informal and unstructured informational interviews and 28 completed semistructured interviews. Twenty-three of the 28 semistructured-interview participants were from my grain-farming target group.

Twelve of the 23 were interviewed once, 8 were interviewed twice, and 3 were interviewed three times. I conducted a total of 37 semistructured interviews with this target group, and 34 of them were audio-recorded and transcribed. Finally, I also conducted six semistructured interviews with representatives from Maryland agricultural agencies and industry groups. These interviews were approximately an hour in length, audio-recorded, and transcribed.

Interviewee Demographics

Demographic data were not systematically taken for the 50 informal and unstructured informational interview participants because of the nature of the meetings. For example, many of the informational interviews were the result of chance meetings with small groups of farmers at fast food restaurants, coffee shops, county Farm Bureau meetings, government-sponsored nutrient-management hearings, informal poultry-grower meetings, and integrator-sponsored poultry festivals. Interviews in these settings were brief and informal and were used as an opportunity to gather general information about grain and poultry production on the LES, as well as farmer interests and concerns regarding *Pfiesteria* and nutrient-management regulations. The most I could determine from many of these brief informational interviews was that the overwhelming majority of interviewees were male and at one time grew grain or raised poultry or both on the LES.

Table 4.2. Semistructured-Interview Participant Demographics.

Sex		
	Total Participants (n=28)	Grain-Farming Target Group (n=23)
Male	82% (23)	83% (19)
Female	18% (5)	17% (4)
Age		
	Total (n=28)	Target Group (n=23)
≤ 44	28% (8)	30% (7)
≥ 45	72% (20)	70% (16)
Agricultural Producers by Type of Production		
	Total (n=28)	Target Group (n=23)
Corn and soybeans	32% (9 men)	39% (9 men)
Corn, soybeans, and poultry (broilers)	39% (9 men/2 women)	48% (9 men/2 women)
Poultry (broilers)	29% (5 men/3 women)	13% (1 man/2 women)
Grain Farmers by Acres Farmed		
	Total (n=20)	Target Group (n=20)
50 to 179 acres	*Same as target group*	50% (10)
180 to 499 acres		15% (3)
500 to 999 acres		10% (2)
≥ 1,000 acres		25% (5)
Poultry Growers by Broiler Houses Operated		
	Total (n=19)	Target Group (n=14)
2 houses	48% (9)	43% (6)
3 to 5 houses	42% (8)	50% (7)
6 to 8 houses	10% (2)	7% (1)

I did collect some demographic data, however, for semistructured-interview participants (see Table 4.2 above). Here I will only highlight grain-farming target-group information. Eighty-three percent (19) of the grain-farming target group (n=23) were men, and 70 percent (16) were 45 years-of-age or older. In addition, nine interviewees (39%, all men) primarily grew corn and soybeans, 11 (48%, 9 men and 2 women) grew corn and soybeans and also raised poultry (broilers), and 3 (13%, 1 man and 2 women) just raised poultry (broilers). Of the three who just raised poultry, one man grew up on a grain farm and previously operated his own grain-farm business. The remaining two were women who also grew up on grain farms where they fully participated in all grain-production activities through early adulthood.

In terms of the 20 interviewees who grew crops, 13 (65%) farmed less than 500 acres, two (10%) farmed 500 to 999 acres, and five (25%) farmed 1,000 or more acres. In addition, all grain farmers identified their businesses as family owned, and the majority had farmed most of their life and used manure (at least in part) to fertilize their crops. A little less than half of those who farmed rented additional farm land. For those 14 who grew poultry, six had two broiler houses, seven had 3 to 5 broiler houses, and one had 6 to 8 houses. Capacity for each broiler house varied and is largely a function of when it was built. Older houses may have a capacity of 16,000 to 17,000 birds and a newer house may have a capacity of 25,000. Data on house capacity were not collected. Finally, all farmers who raised poultry were contract growers, identified themselves as family-owned businesses, and had over 10 years of poultry-production experience.

Nine of the 23 semistructured interview participants in the grain-farming target group were key informants (see Table 4.3 below). I refer to these nine as key informants because they were very adept at communicating their cultural knowledge and I relied heavily on their insights. I conducted at least two semistructured interviews with them and routinely contacted them when I had questions that needed clarification. In this group of men, four grew grain, another four grew grain and raised poultry, and one just raised poultry. Even though the latter man only raised poultry, he had considerable grain-farm experience from growing up on a grain farm and previously operating his own grain-production business. In Table 4.3, I list the pseudonyms of these key informants along with some general descriptive data. I refer to them by pseudonyms and provide limited personal data to protect their anonymity.

Table 4.3. Key Informant Information.

	Age	**Type of Production**	**Acres Farmed**	**Poultry Houses**
Stephen Borg	≥ 45	Grain/poultry	50 to 179	3 to 5
Tom Carter	≥ 45	Grain	≥ 1,000	0
Patrick Casey	≤ 44	Grain	≥ 1,000	0
Elmer Henkle	≤ 44	Grain/poultry	50 to 179	2
Gary Knight	≥ 45	Grain/poultry	180 to 499	2
Donny Mueller	≥ 45	Poultry*	0	6 to 8
Rodney Rademann	≤ 44	Grain	500 to 999	0
Greg Schaffer	≤ 44	Grain/poultry	500 to 999	3 to 5
Mike Williams	≤ 44	Grain	≥ 1,000	0

*Previously owned and operated a grain farm.

Data Analysis

Following D'Andrade (1987, 1995, 2005) and Quinn (1987, 1997, 2005b, c), my data analysis consisted primarily of the cultural analysis of discourse. Discourse in this sense refers to "language in use, either spoken or written, and typically consisting of segments of speech or written text longer than single words or sentences" (Quinn 2005c:4-5). More specifically, the discourse I analyzed was transcribed "talk" from semistructured interviews and public hearings. To better facilitate my cultural analysis of these transcripts, I used Atlas.ti (Muhr 2006)--a qualitative text-analysis software package--to organize and code my findings (Lewins and Silver 2007). Through cultural analysis, my general task was to interpret the implicit meanings found within segments of transcribed talk and determine the extent to which these meanings were shared among LES farmers in the grain-farming target group. Quinn (2005c:4) described the use of cultural analysis in her cultural-models research in the following way:

> Cultural analysis, then, refers here to the effort to tease out, from discourse, the cultural meanings that underlie it. These cultural meanings are implicit in what people say, but rarely explicitly stated. In schema theoretic terms, this lack of isomorphism between what people know and what they can state arises because cultural understandings reflect the experience from which they have been learned, and this experience often occurs in nonlinguistic contexts, unattached to language. Only under special circumstances (such as some kinds of formal teaching) does experience come to us codified in language or is it translated into language. So the tacit understandings that underlie discourse must be reconstructed from the clues that this discourse provides.

Quinn (2005c:4) further adds that she came to see her cultural-analysis approach as "the reconstruction, from what people said explicitly, of the implicit assumptions they must have in mind to say it."

In analyzing my transcript data, I employed several cultural-analysis tools used by Quinn (1997; 2005b, c) and D'Andrade (2005). In general, I looked for explicit propositions and the taken-for-granted presuppositions found within them. In addition, I looked for implicit understandings contained within metaphors found in segments of transcribed talk. Also, I explored the use and meaning of key words in context, as well as how informants reasoned about and integrated and related their understandings of particular topics and beliefs. Moreover, I looked for shared understandings (implicit and explicit) and patterns within and across various domains (Bernard and Ryan 1998; Ryan and Bernard 2003), and investigated the relationships between these shared findings--particularly those between shared implicit and explicit understandings. My general goal was to determine whether my data and cultural analysis provided evidence of the existence of cultural schemas or models that LES farmers in the grain-farming target group shared and drew on to inform their understandings of, and guide and motivate their responses to, Maryland's nutrient-management policy efforts.

The cultural-models approach and study design I employed for this research were originally set up to determine the extent to which a broad sample of Maryland environmental professionals, farmers, and watermen used different or complementary cultural models to understand a related range of environmental and nutrient-management policy issues. To accomplish this task, semistructured interviews focused on eliciting knowledge of each groups generally held cultural models, as well as any differences that may exist between them. My data analysis capabilities are wedded to and limited by this approach and research design. For example, I have the sample size and data needed to determine the existence of generally held cultural models among my grain-farming target group. I do not, however, have the sample size or data to determine with any rigor the presence of intracultural variation and competing cultural models among different types or categories of farmers--operation type and size; operator age, experience, education, and goals. This limitation prevents me from exploring the existence of divergent cultural models among different categories of farmers that may have particular policy relevance in creating and implementing nutrient-management programs. Nevertheless, I demonstrate in subsequent chapters that knowledge of the shared cultural models found among the grain-farming target group can make a significant contribution to nutrient-management policy and program efforts.

It is also important to emphasize that my data-analysis approach, which draws on cognitive theory and cultural models work, contains both emic and etic components (Bernard 1995). It consists of emic analyses in the sense that it captures farmer understandings of their own shared beliefs and values, which is explicit knowledge that they can readily articulate. It also contains etic analyses because much of farmers' shared knowledge is implicit and outside their conscious awareness and is only made knowable in a comprehensive and coherent manner through interpretation.

In a final data-analysis note, I have previously published three journal articles from the data in my dissertation: "Farmer Morality and Maryland's Nutrient Management Regulations" (Paolisso and Maloney 2000a), "Recognizing Farmer Environmentalism: Nutrient Runoff and Toxic Dinoflagellate Blooms in the Chesapeake Bay Region" (Paolisso and Maloney 2000b), and "The 'Art of

Farming': Exploring the Link between Farm Culture and Maryland's Nutrient Management Policies" (Maloney and Paolisso 2006). My dissertation will draw on aspects of these articles, but will not simply replicate their findings.

Chapter 5

Chesapeake Bay Restoration and Maryland's Nutrient-Management History

Early Efforts to Address Chesapeake Bay Health

Maryland's interest in nutrient runoff and management has historically been linked to concerns over pollution in the Chesapeake Bay. In 1975, the U.S. Congress, prompted by concerns over the declining health of the Chesapeake Bay, made it the first U.S. estuary to be targeted for protection and restoration (MCE 2006a; Sims and Coale 2002; STAC 2004). And to better understand threats to bay health, Congress authorized the U.S. Environmental Protection Agency (EPA) to conduct studies over the next five years to determine the causes of the bay's declining water quality (CBP 1982; MCE 2006a; Sims and Coale 2002; STAC 2004). About 40 research projects were conducted, and by the early 1980s studies documented "declining water quality and reduction in the numbers and diversity of fish, shellfish, and submerged aquatic vegetation (SAV)" (MCE 2006a:1). Studies also found that eutrophication (excess nutrients accelerate algae growth and deplete water of dissolved oxygen [CBP n.d.]), turbidity (excess suspended sediments in water), and hypoxia (low oxygen levels in water) from soil and nutrient runoff were the main causes of these water quality changes (Boesch, Brinsfield, and Magnien 2001; CBP 1982). More specifically, studies concluded that the most significant pollution problem affecting the bay was nutrient enrichment from nonpoint sources, which were estimated to contribute 50 to 55 percent of nitrogen and 30 to 34 percent of phosphorus loads to the bay (Smullen, Taft, and Macknis 1982). Agricultural cropland was the greatest contributor of nonpoint-source nutrients to the bay, accounting for an estimated 45 to 70 percent of nitrogen and 60 to 85 percent of phosphorus loads (ibid.).

In an attempt to address bay problems, Maryland, Virginia, Pennsylvania, the District of Columbia, and EPA created the Chesapeake Bay Program (CBP) in 1983 to coordinate and facilitate improvement efforts (CBP 2005). Reflecting on current bay research, CBP members determined that nutrient reduction was the best way to improve "habitat for benthic [bottom-dwelling] organisms and fish by reducing algal blooms [dense populations of algae fueled by nutrients] and increasing light penetration to SAV" (MCE 2006a:1). Water-quality models were then developed to determine nutrient-reduction needs, and a 40 percent reduction goal from 1985 levels was established for the bay by 2000. In 1987, another bay agreement was signed by the same parties to officially adopt this 2000 nitrogen and phosphorus reduction goal (CBP 2005; MCE 2006a). In addition, as part of the larger effort to reduce bay nutrient loadings, CBP members agreed in 1992 to pursue reduction goals past 2000 to reduce nutrients in bay tributaries (CBP 2005). In doing this, Maryland (as well as other program members) developed tributary strategies for each of its major watersheds, which required each to meet its own nutrient-reduction goals as a means to achieve Maryland's 40 percent reduction goal (CBP 2005; MCE 2006a). Maryland designated 10 discrete geographic areas or major tributary basins in its portion of the larger bay watershed where it would work to reduce nutrient loads to the bay. Three of these tributary basins are on Maryland's Eastern Shore--Upper Eastern Shore, Choptank, and Lower Eastern Shore (see Figure 3.5)--one of which is my Lower Eastern Shore study area (Favero 1997; MDNR 2008).

Maryland's Voluntary Nutrient-Management Program

Spurred in part by bay nutrient-runoff findings and Clean Water Act requirements to address agricultural pollution in the early 1980s, Maryland began more formal efforts to develop and promote voluntary programs and best-management practices (BMPs) to reduce farm runoff. These efforts progressed slowly, and water-quality monitoring data showed little improvement in bay nutrients levels. It was not until the 1987 bay agreement--when Maryland committed itself to achieving certain nutrient-reduction goals by 2000--that Maryland stepped up its efforts to address agricultural nutrient runoff by pledging to develop a formal voluntary nutrient-management program (CBP 1992; Ernst 2003; Herbst 2005; MCE 2006a).

Maryland Department of Agriculture (MDA) and the University of Maryland Cooperative Extension (MCE) worked cooperatively to create the Maryland Nutrient-Management Program (MNMP), which was implemented in 1989. The MNMP was a volunteer program designed to reduce agricultural nutrient runoff through erosion control practices and the widespread use of nitrogen-based nutrient-management plans ([NMPs] Leffler 1997; MCE 2006a; Staver and Brinsfield 2001). In general, NMPs are a tool to manage the amount, placement, timing, and application of fertilizer to minimize nutrient loss or runoff and maintain the productivity of soil. NMPs help farmers match nitrogen-application rates to crop needs as closely as possible to limit the potential for excess soluble nitrogen to be lost through surface runoff and subsurface drainage (Staver and Brinsfield 2001). Like NMPs, erosion-control practices also help to reduce nutrient losses because soil particles are thought to be the primary transport mechanism for phosphorus runoff.

As a part of the MNMP, MDA and MCE offered a range of educational and technical assistance services and financial incentives to encourage farmers to adopt program measures. For example, the state used these instruments to facilitate erosion and sediment control measures like reduced-till farming and the installation of riparian buffer zones and grass waterways. These same resources were used to get farmers to voluntarily adopt nitrogen-based NMPs and the BMPs associated with them, including: record keeping of applied nutrients and crop yields on individual fields to better determine nutrient requirements; taking soil and manure samples to calculate nutrient content and availability; calibrating nutrient-application equipment to better achieve desired application rates; timing application of fertilizers to coincide with crop uptake; and planting cover crops for residual nitrogen uptake (Smith 1998; Staver and Brinsfield 2001). In addition, those farmers who raised poultry were given financial incentives to construct manure storage structures. These structures were "intended to reduce the potential for nutrient runoff and leaching from stored manure and also to make it possible to more closely time manure application to coincide with crop nutrient needs" (Staver and Brinsfield 2001:861).

An important component of the nutrient-management program was manure education. MDA and MCE worked with farmers to help them become better aware of manure's nutrient value so that its application would not exceed crop nitrogen needs, which would also reduce total phosphorus inputs. In terms of the latter, "animal manure and sewage sludge tend to be enriched in phosphorus relative to crop needs" (Staver and Brinsfield 2001:860). As a result, farmers who use manure to meet crop nitrogen needs will typically apply three to four times more phosphorus than crops require (Coale 2000; Staver and Brinsfield 2001). Thus, by educating farmers to not over apply manure in meeting crop nitrogen needs, phosphorus applications are also reduced.

Moreover, the primary goal of the MNMP was to place around 1.3 million acres of Maryland farmland (60%) under nitrogen-based NMPs by the year 2000 (Blankenship 1994; Leffler 1997; MCE 2006a). The MNMP was the first such volunteer program in the country and was widely supported. In fact, the MNMP was so popular that it almost obtained its 2000 acreage goal for NMPs a full two years early (Leffler 1997; Ventsias 2002). Over the course of the 1990s, Maryland farmers had NMPs written for the following acreage: by June 1994, 507,000 acres (Blankenship 1994); by June 1997, more than 800,000 acres (Leffler 1997); and by April 1998, more than 1 million acres (Gardner et al. 2002). According to Louis Lawrence, chief of the Resource Conservation Division of MDA, farmers met the MNMP year-2000 goal for number of acres under NMPs (personal communication, July 26, 2000).

Critique of Voluntary Efforts, Pursuit of Regulations, and Reevaluation of Bay Goals

From the inception of the voluntary MNMP in 1989, pro-environmental interests at the state and federal levels were convinced that these efforts were not adequate to meet bay nutrient-reduction goals and that regulatory measures were necessary to achieve them. An independent panel convened by the CBP in 1989 concluded that existing nonpoint-source nutrient-reduction measures were inadequate to meet year-2000 goals (CBP 1990). The panel's comments in regard to measures to address agricultural runoff were similar to those that would be made by others in the late 1990s: too few farmers were participating in conservation programs, adoption rates of voluntary BMP programs and practices were too slow and not verifiable, and water-quality improvements were not occurring as a result of their increased conservation efforts. These factors led the panel to conclude that voluntary measures were ineffective and that state and federal government should increasingly use regulatory authority to reduce agricultural runoff (ibid.).

Many in the environmental community shared the CBP panel's beliefs and also advocated for regulatory measures that would require farmers to better control nutrient runoff. These critics cited too little progress in enrolling farm acres in the MNMP and a belief that farmers were unwilling to take necessary measures to reduce their nutrient-runoff contributions as reasons for nutrient-management regulation (Blankenship 1994; Ernst 2003; Herbst 2005). Maryland Cooperative Extension surveys conducted in the late 1980s and early 1990s also seemed to suggest that the MNMP might not be adequate to meet bay nutrient-reduction goals (Lichtenberg 1996). For example, findings from 1986, 1991, and 1995 agricultural surveys showed that progress in expanding some conservation practices had stalled and the use of conservation tillage and cover crops had declined since 1986 (ibid.).

As a result of growing dissatisfaction over what was considered inadequate farmer participation in the MNMP, and CBP reports of too little improvement in reducing bay nutrient levels, some environmental enthusiasts pursued legislation to regulate farmers' nutrient-management practices. Maryland Senator Gerald Winegard, who chaired the Subcommittee on the Chesapeake Bay and the Environment, and the Chesapeake Bay Foundation (CBF), the leading bay environmental-advocacy group, spearheaded legislation in 1992, 1993, and 1994 to require mandatory nutrient planning for farmers. Each of these legislative efforts was unsuccessful. MDA and agricultural interest-group lobbying played a key role in their failure (Belousek 2004; Ernst 2003; Favero 1997; Herbst 2005).

Despite these legislative defeats, there was a solid, growing consensus by the late-1990s among environmentalists, as well as some agricultural scientists, that agricultural nutrient runoff was a serious threat to bay water quality, that current voluntary efforts to reduce farm runoff were inadequate, that regulatory measures were needed to meet year-2000 nutrient-reduction goals, and that baywide nutrient-reduction accomplishments were overly optimistic and did not reflect tributary findings (Belousek 2004; Staver and Brinsfield 2001). Two significant publications in 1995 by Boynton et al. (1995) and Magnien, Boward, and Bieber (1995) confirmed the sources of nutrient pollution to the bay (Boesch, Brinsfield, and Magnien 2001; Sims and Coale 2002).

Boynton et al. (1995) estimated that 28 percent of bay nitrogen came from point sources, 60 percent from nonpoint sources, and 12 percent from atmospheric sources. In comparison, Magnien, Boward, and Bieber (1995) concluded that 23 percent of bay nitrogen came from point sources, 66 percent from nonpoint sources, and 11 percent from atmospheric ones. In addition, Boynton et al. (1995) suggested that 35 percent of bay phosphorus came from point sources, 58 percent from nonpoint sources, and another 7 percent from atmospheric sources. Again by comparison, Magnien, Boward, and Bieber (1995) stated that 34 percent of bay phosphorus came from point sources, 60 percent from nonpoint sources, and the remaining 6 percent from atmospheric ones. Moreover, Boynton et al. (1995)

estimated that contemporary nitrogen loading rates to the bay were 5 to 8 times higher than those before European settlement, and that phosphorus loadings were 13 to 24 times higher. Finally, Magnien, Boward, and Bieber (1995) broke down the sources of nonpoint-source pollutants and estimated that agriculture contributed 39 percent of nitrogen and 49 percent of phosphorus loads to the bay. These amounts were significantly more than any other point, nonpoint, or atmospheric source (Boesch, Brinsfield, and Magnien 2001; Sims and Coale 2002).

With the need to achieve year-2000 goals only a few years away, the CBP in 1997 evaluated water-quality progress to date and assessed the potential for goal attainment. Using baywide water-quality modeling data, the CBP reported that phosphorus-reduction goals would be met, but that nitrogen-reduction goals would fall short (CBP 1997, 1998). However, CBP reported that in areas of the bay where tributary strategies had been implemented (Susquehanna, Potomac, Patuxent, and Eastern and Western Shores of Maryland), nitrogen- and phosphorus-reduction goals would be fully met (CBP 1997, 1998; Staver and Brinsfield 2001). Despite these somewhat favorable projections, many in the environmental community argued that these findings were overly optimistic and flawed and did not reflect actual reductions from nonpoint sources, as well as data trends from water-quality monitoring stations. For example, Staver and Brinsfield (2001) noted that phosphorus-reduction goals were largely accomplished due to a ban on phosphate detergents that effectively cut phosphorus point-source loads in half over a decade, and not by significant reductions to nonpoint-source phosphorus loads. In addition, tidal monitoring station data from the Eastern Shore--one of the densest agricultural production areas in the Chesapeake Bay watershed--showed little or no progress in reducing nutrient levels (Blankenship 1998; Staver and Brinsfield 2001). In fact, data suggested that nutrient concentrations in major ES tributaries, particularly those on the Lower Eastern Shore of Maryland, were actually increasing. And given the density of agricultural production in these areas, especially poultry production, environmental scientists considered it the primary nutrient-runoff source (Blankenship 1998; Staver and Brinsfield 2001).

Along with data indicating that water quality was not improving in dense agricultural areas, MCE survey findings in 1997 and 1998 on farmer nutrient-management practices suggested (again) that farmer participation in the MNMP may be inadequate. For example, a 1998 follow-up study showed that a growing percentage of Maryland farmers were not using any conservation practices and that the use of manure-storage structures had declined (Lichtenberg 2000). And several 1997 MCE surveys (looking at 1996 production activities) raised concerns that insufficient numbers of farmers had nutrient-management plans and that many of those who had plans were not fully implementing them (Smith 1998, 1999). The same surveys also suggested that many of those with and without plans were applying manure at suboptimal times and had unrealistic yield goals that resulted in the excessive application of nutrients (Smith 1998, 1999). Thus, many environmentalists saw the findings from MCE survey data, as well as ES tidal monitoring-station data, as direct proof that voluntary-, education- and incentive-based programs had failed to reduce agricultural nutrient runoff and were incapable of achieving year-2000 goals (Staver and Brinsfield 2001).

New Phosphorus Science Challenges Adequacy of Voluntary Program

Another contributing factor to the growing opposition to the voluntary MNMP was new scientific understandings of phosphorus fate and transport that evolved over the last two decades (Staver and Brinsfield 2001). Up until the early 1990s, the common understanding among many soil scientists was that phosphorus chemically bound itself to most soils and that soil erosion was the primary transport mechanism for phosphorus runoff. Along with these notions was the belief that it was not likely that soils could be become sufficiently saturated with phosphorus to the point it would no longer bind with soil sediment and leave cropland as soluble phosphorus through surface runoff or leaching (Coale 2000; Staver and Brinsfield 2001; Ventsias 2002). Staver and Brinsfield (2001:862) note that even recent college textbooks on soil have described the "phosphorus problem," not as runoff, but as the tendency for "soluble phosphorus added to agricultural soils to be converted to insoluble forms unavailable for plant uptake." Generally speaking, particulate phosphorus found in soil runoff was thought to account for 70 to 90 percent of phosphorus losses. The algal bioavailability of particulate phosphorus to a phosphorus-limited water body ranges anywhere from 10 to 90 percent bioavailable (ibid.).

The voluntary Maryland Nutrient-Management Program was based on this overall understanding of phosphorus. New scientific findings, however, suggested that in areas where concentrated animal production exist, and phosphorus-rich animal wastes are used repeatedly to fertilize crops, phosphorus levels near the soil surface have become so elevated that they no longer bind to soil sediment and instead exist in soluble forms that are highly susceptible to surface runoff (Coale 2000; MCE 1997; Staver and Brinsfield 2001). Where past research suggested that only 10 to 25 percent of phosphorus losses in the form of surface runoff from agricultural fields were in the form of dissolved phosphorus, new studies suggest that more than 50 percent can be in the form of dissolved phosphorus (Coale 2000). High concentrations of dissolved phosphorus in surface runoff to phosphorus-limited water bodies are particularly problematic because it is practically 100 percent bioavailable to algal species (Coale 2000; Staver and Brinsfield 2001). Studies have even shown a linear relationship between soil phosphorus concentrations and the concentration of dissolved phosphorus in field drainage water (Staver and Brinsfield 2001).

Similarly, potential phosphorus losses in lateral subsurface flow through artificial drains, macropores, and earthworm holes below the surface and matrix flow downward through the soil profile into groundwater tend to increase as soil-phosphorus concentrations increase. This is particularly true for coarse-textured soils in the Atlantic Coastal Plain that have a high sorbing capacity (Boesch, Brinsfield, and Magnien 2001; Butler and Coale 2005; Coale 2000; MCE 1997; Staver and Brinsfield 2001). In addition, studies have also shown that phosphorus from plant residues, recently applied organic fertilizers on the soil surface, and fertilizers applied to reduced-till cropland can significantly contribute to phosphorus runoff. (For a more detailed discussion of current scientific understandings of phosphorus use, management, and transport in agricultural settings, see Frossard et al. 2000; Haygarth and Sharpley 2000; Higgs et al. 2000; Maguire, Sims, and Coale 2000; Sharpley 2000; Sharpley, Foy, and Withers 2000; Sims et al. 2000).

Implications of New Phosphorus Findings and Eastern Shore Nutrient-Runoff Threats

The implications of these new phosphorus understandings for the Maryland Nutrient-Management Program and the Eastern Shore of Maryland are considerable. As suggested, the MNMP was based on previous understandings of phosphorus mobility, so it did not include measures to address soluble-phosphorus runoff. This is significant for the ES given that it has the highest concentration of grain and poultry production in the entire bay watershed, making it a particularly problematic nutrient sink. As a nutrient sink, it is susceptible to runoff from the use of high levels of organic and inorganic nitrogen fertilizer and phosphorus-rich poultry manure that is typically used in high-yielding conventional grain-production systems. Moreover, these new phosphorus findings are even more alarming for the LES, which has the highest poultry concentration on the Eastern Shore (Sims and Coale 2002; Staver and Brinsfield 2001). In addition, the ES's irregular shoreline and numerous streams and tributaries that feed into the bay make nutrient runoff an even greater threat to the bay because it directly links runoff to bay tidal waters (Staver and Brinsfield 2001).

Furthermore, Maryland soil-fertility tests confirmed that soil-phosphorus levels were high in areas like the ES where poultry manure and other high-phosphorus wastes are being used to meet crop nitrogen needs (Coale 2000; Coale, Sims, and Leytem 2002; MCE 1997; Staver and Brinsfield 2001). University of Maryland Soil Testing Laboratory data from 1997 show soil tests to be "optimum" or "excessive" for phosphorus in the three Lower Eastern Shore counties of Somerset, Wicomico, and Worcester, where broiler production is concentrated. "Soils that test 'optimum' or 'excessive' require very little or no phosphorus fertilization in order to achieve maximum yields" (Coale 2000:47). Soluble phosphorus losses, which are readily available for plant use, are thought to be the result of surface runoff from these highly enriched phosphorus soils and have been found in ES waters at levels disadvantageous for aquatic ecosystems. Phosphorus losses were also attributed to poultry manure applied in reduced-tillage settings where it remains on the soil surface and from the leaching of plant residue after harvest (Coale 2000; Staver and Brinsfield 2001; Ventsias 2002).

These findings present new challenges because Maryland has actively promoted reduced-tillage as a preferred approach to reduce soil erosion, and plant residue also helps to prevent erosion.

Further confirmation of the threat that agricultural nutrient runoff posed to elevated bay nutrient levels came from additional watershed modeling and water monitoring estimates in the late 1990s. These findings suggested that 60 percent of Eastern Shore nitrogen inputs to the bay came from agriculture, half from animal manure (Boesch, Brinsfield, and Magnien 2001). Environmental scientists also estimated that 70 percent of LES nitrogen inputs to the bay, and 82 percent of phosphorus inputs, came from agricultural runoff (Sims and Coale 2002). Boesch, Brinsfield, and Magnien (2001) similarly reported that 74 percent of nitrogen loads, and 70 percent of phosphorus loads, to the Pocomoke River watershed (located within the LES) come from agricultural sources.

Nevertheless, several problems exist that make it difficult to accurately determine nutrient loading to tributaries and the role of agriculture in this process. First, since CBP efforts to reduce nutrient loads to the bay in the 1980s, there has been little baseline nonpoint-source nutrient-load data from the ES. This has made it difficult to accurately demonstrate whether farmers' nutrient-management efforts have or have not reduced nutrient loads to bay tributaries (Staver and Brinsfield 2001). And second, there appears to be a significant lag time between changes in nutrient-management practices and water-quality improvements (Blankenship 2007a; Favero 1997; Leffler 1997). For example, since nitrogen is thought to primarily leave ES cropland through subsurface transport to groundwater, it can take five to ten years or more for nitrogen to make its way to surface waters. In fact, U.S. Geological Survey studies in the bay region estimate that on average, "it takes a decade before half of the nitrogen that sinks into groundwater seeps into a stream," and the rest can take even longer (Blankenship 2007a:1). Thus, nutrient loadings to tributaries may inaccurately reflect actual nutrient-reduction accomplishments that will not be measurable until sometime in the future (Blankenship 2007a; Favero 1997; Leffler 1997).

Pfiesteria **and the Nutrient-Management Policy Debate**

Maryland and other CBP partners were already critically reviewing their nonpoint-source nutrient-reduction efforts and questioning their ability to achieve year-2000 nutrient-reduction goals when, in the fall of 1996 and spring of 1997, watermen working in the Pocomoke River on Maryland's Lower Eastern Shore of the Chesapeake Bay reported finding lesions on a high percentage of their fish catches. Some watermen also reported that they were suffering ill-health related to their exposure to fish lesions. In the spring and summer of 1997, Maryland Governor Paris Glendening appointed several teams of scientists to conduct water-quality tests and medical evaluations to investigate the cause of fish lesions and their relationship to reported adverse human-health effects. Early speculation was that a toxic form of the newly discovered dinoflagellate, *Pfiesteria piscicida*, was a likely cause of adverse health effects in fish and humans (Burkholder and Glasgow 2001; Hughes 1997; Magnien 2001).

Pfiesteria

Pfiesteria represents a new family, genus, and species of toxic dinoflagellate (Burkholder and Glasgow 2001). Two toxic species have been identified--*Pfiesteria piscicida* and *Pfiesteria shumwayae*--but *Pfiesteria piscicida* has been more widely linked to diseased and dead fish in the Chesapeake Bay. Other *Pfiesteria*-like organisms have also been reported, but none were found to be toxic. *Pfiesteria* is thought to be a very complex dinoflagellate that can exist in more than 20 stages or forms, including multiple amoeboid, flagellated (zoospore), and cyst (dormant) stages. Unlike other dinoflagellates that exhibit plant-like characteristics, *Pfiesteria* has animal-like qualities and is the first toxic dinoflagellate shown to attack fish (ibid.).

Pfiesteria has a wide range of food sources, from bacteria and algae to mammalian tissues, live and dead. *Pfiesteria* zoospores feed on fish tissue by extending and attaching their peduncles to a red blood cell and sucking out its contents. Toxic strains of *Pfiesteria* are also stimulated by inorganic and organic phosphates and nitrates in varied ways. Burkholder and Glasgow (1997) note that inorganic phosphate can directly stimulate toxic *Pfiesteria* zoospores, and both inorganic phosphate and nitrate can indirectly increase production of temporarily nontoxic *Pfiesteria* zoospores by stimulating their algal prey. Sources of inorganic nutrients may be fertilizer runoff from cropland and lawns (Burkholder and Glasgow 2001).

Also, Burkholder and Glasgow (1997) add that through osmosis *Pfiesteria* takes up organic phosphate and nitrogen, and both toxic and temporarily nontoxic zoospores are stimulated by organic phosphate. Sources of dissolved organic nutrients can enter water bodies in the form of poorly treated sewage and animal wastes (Burkholder and Glasgow 2001). *Pfiesteria* can also use "photosynthesis as a borrowed nutritional mode by retaining the chloroplasts from algae that it consumes" (ibid.:831). Interestingly, *Pfiesteria* zoospores with chloroplasts called kleptochloroplasts can proliferate when directly stimulated by inorganic nitrate and phosphate. Burkholder and Glasgow (2001) claim that approximately 75 percent of toxic *Pfiesteria* outbreaks in North Carolina through 1997 occurred in waters with high nutrient concentrations from sources like cropland runoff, poorly treated human sewage, and animal wastes, making the strong link between nutrient runoff and incidences of toxic *Pfiesteria*.

Pfiesteria has been found to show a range of toxicity, from highly toxic strains to ones that are benign or noninducible. Researchers believe that *Pfiesteria* needs to be in the presence of live fish or their fresh secretions, excretions, and tissues to become toxic, and benign strains in the presence of fish are unable to engage in toxic activity. Most of the toxic *Pfiesteria* isolates in North Carolina and Maryland have been collected from waters where in-progress kills of juvenile Atlantic menhaden were taking place. Menhaden are small oily fish that travel in dense schools and move upriver from the ocean during the spring and summer, feeding till early fall in poorly flushed, nutrient-rich, warm, brackish, shallow estuaries like those found in the Chesapeake Bay. Burkholder and Glasgow (2001) hypothesize that dense schools of menhaden excrete unidentified chemical cues that stimulate *Pfiesteria* zoospores to produce toxins that narcotize and then cause disease or death in fish. With or without the direct contact of toxic *Pfiesteria* zoospores to fish, toxic *Pfiesteria* can cause death in fish, as well as hemorrhaging and skin lesions that are "diffuse or nonfocal, as well as deep, localized or focal, bleeding sores or ulcerations" that may or may not lead to death (ibid.:833-834). In toxic form, *Pfiesteria piscicida* have been found to be lethal to more than 30 finfish and shellfish species (Burkholder and Glasgow 2001).

Burkholder and Glasgow (2001) also note that toxic *Pfiesteria* can be linked to human illness. From their own laboratory experiences, a dozen staff became ill as the result of inhaling aerosols from and skin contact with toxic *Pfiesteria* water cultures. Symptoms included "blurred vision, burning skin and eyes, acute respiratory difficulty, muscle cramping, nausea, vomiting, severe headaches, and profound memory dysfunction" (ibid.:835). As a result, Burkholder and Glasgow (2001) concluded that people were at risk of serious health effects from sustained contact with toxic *Pfiesteria*-infected waters or aerosols. However, they also reported that people did not appear to be adversely affected by eating seafood from these infected waters (ibid.).

Maryland’s Early Efforts to Identify and Address *Pfiesteria* Threats

In May of 1997, a Washington, D.C., news reporter working with LES watermen collected water samples from the Pocomoke River and sent them to Burkholder for analysis. Burkholder’s findings confirmed the presence of *Pfiesteria*-like organisms in sufficient density to cause lesions and death in fish if toxic. Fish bioassays were also conducted from these water samples and were found to be toxic to fish. Scanning electron microscopy (SEM) analyses of the fish bioassays were then conducted to determine the type and concentration of organisms present at death, and *Pfiesteria* was conclusively identified at sufficiently high concentrations to kill fish. Shortly after receipt of the water samples and her analysis of them, Burkholder concluded in a televised news report that she had found toxic *Pfiesteria* in the Pocomoke River. Burkholder’s report fueled an already growing belief among Chesapeake Bay environmentalists, scientists, and reporters that toxic *Pfiesteria* was a serious threat to fish and human health. In addition, the idea that nutrient runoff from agricultural operations was the primary cause of nutrient-enriched waters in which *Pfiesteria* thrived gained momentum. Burkholder’s report set off a local, regional, and national media blitz that made *Pfiesteria* in the Chesapeake Bay front page news for months to come (Burkholder and Glasgow 2001; Hughes 1997; Magnien 2001).

Further cementing the notion of *Pfiesteria’s* ill effects, four separate incidences of thousands of diseased and dead fish were reported in August and

September in three LES tributaries (Pocomoke River, 2 events; Kings Creek; and Chicamacomico River). Burkholder concluded from water samples that *Pfiesteria*-like organisms were present in sufficient quantity to kill fish, if toxic, and that fish bioassays and SEM analyses identified the presence of toxic *Pfiesteria* (Burkholder and Glasgow 2001; Magnien 2001). Equally significant were medical findings from the Maryland medical team that human contact with diseased and dead fish and toxic *Pfiesteria* blooms could result in ill-health, including acute respiratory and eye irritation, gastroenteritis, fatigue, headaches, and short-term dermatologic and cognitive impairments (Grattan et al. 1998; Grattan, Oldach, and Morris 2001; Hughes 1997). To guard against any effects from potential exposure to toxic *Pfiesteria*, rivers were temporarily closed after the discovery of diseased and dead fish, and a protocol was established to close and reopen rivers affected by *Pfiesteria* or *Pfiesteria*-like events (Hughes 1997).

Given the growing public, media, and scientific concern over *Pfiesteria*, Governor Glendening formed the Blue Ribbon Citizens *Pfiesteria* Action Commission in September 1997 to assess the scientific evidence surrounding *Pfiesteria*, as well as its relationship to nutrient runoff, and to provide policy recommendations to address the problem. The commission was to report its findings to the governor by November 1 (Hughes 1997). Once a probable link between toxic *Pfiesteria* and fish kills was established, Maryland scientists drew on research to help determine what was responsible for the growth of *Pfiesteria*, how it became toxic, and the nature of its toxicity. In this process, Maryland relied heavily on Burkholder to help confirm the presence of toxic *Pfiesteria* in Maryland waters and to advise the governor's commission on the science of *Pfiesteria* and the role of nutrients in related outbreaks (Belousek 2004; Hughes 1997; Magnien 2001).

Research suggested that nutrient-rich waters like those found on the LES were ideal for *Pfiesteria* growth, but provided little evidence as to what causes *Pfiesteria* to become toxic or the characteristics of the toxin. The general working hypothesis, which closely paralleled Burkholder's findings, was that nutrient-rich waters on the LES allowed *Pfiesteria* to flourish, and large numbers of schooling menhaden in these shallow *Pfiesteria*-infested waters secreted oils or chemicals that triggered *Pfiesteria* to become toxic. Given new scientific research that showed that phosphorus runoff on the ES was more problematic than originally assumed, Burkholder's finding that toxic *Pfiesteria* could be stimulated by phosphorus-enriched waters drew significant attention.

The *Pfiesteria* commission's report to the governor concluded that even though there was considerable scientific uncertainty surrounding what caused *Pfieseria* or *Pfiesteria*-like organisms to become toxic, there was general scientific consensus that nutrient-rich waters played a major role in *Pfiesteria* growth, and measures taken to reduce nutrient runoff would reduce the threat of harmful algal blooms (Hughes 1997; Terlizzi 2006). The commission also recommended that the state require all farmers to adopt nitrogen- and phosphorus-based nutrient-management plans by 2000 and fully implement them by 2002 (Hughes 1997).

The theory that toxic *Pfiesteria* was responsible for dead and diseased fish in the Chesapeake Bay, and by association, that nutrient runoff contributed to its presence, did not go unchallenged (Kaiser 2002; Terlizzi 2006). Some scientists argued that links between nutrients and harmful algal blooms are not always clear, and that diseased and dead fish could be the result of a combination of factors, including other dinoflagellates like *Karlodinium micrum* (K. micrum)--which is not toxic to humans--low oxygen levels, and fungus (Kaiser 2002; Terlizzi 2006). Other scientists noted that Burkholder's toxic *Pfiesteria* findings were the result of laboratory tests with too few controls. For example, toxic *Pfiesteria* determinations were made by placing fish in tanks with *Pfiesteria* to see if the fish die. According to some scientists, this is problematic because more than 60 other organisms--bacteria, eukaryotes, fungi--have been found to live in these tanks, making toxic determinations difficult (Kaiser 2002).

Others challenged Burkholder's findings on *Pfiesteria's* unique life history, ability to cause lesions, and toxic potential (Kaiser 2002; Terlizzi 2006), as well as its threat to public health (Griffith 1999). Of particular importance were findings among some scientists that *Pfiesteria* is not toxic, kills fish by feeding on them, and that mortality is less likely outside the laboratory where fish can evade *Pfiesteria* (Kaiser 2002). In addition, David Griffith's (1999) work in North Carolina contextualized *Pfiesteria's* threat to human health and concluded that it was exaggerated and detracted attention and resources away from more devastating environmental-health risks (rabies, lead poisoning, food contamination, occupational injury).

Policy Debate

With the announcement of the Blue Ribbon Citizens *Pfiesteria* Action Commission findings, and the tenuous link between nutrient runoff, *Pfiesteria*, and fish kills established, Maryland farmers' nutrient-management practices came under fire from a cadre of environmentalists, governmental and nongovernmental groups, and regional and national news media. An impassioned policy debate ensued in the fall of 1997 over how best to address *Pfiesteria* and agricultural nutrient runoff concerns that pitted farmers and other agricultural interests against Maryland environmental interest groups, pro-environmental legislators, the governor's office, and state environmental agencies. At the center of this heated debate was whether farmers' nutrient-management practices should be regulated. Environmental interests in Maryland had repeatedly attempted and failed to pass legislation to regulate farmers' use of nutrients. The *Pfiesteria* threat was their best hope to realize this goal.

In January 1998, Governor Glendening introduced the Water Quality Improvement Act to the Maryland Senate, which outlined a regulatory program to control farm nutrient runoff. Farmers, poultry companies, and agricultural suppliers and service providers adamantly opposed proposed regulations and saw these efforts as unfair and unnecessary. Farmers argued that they were already participating in the most successful voluntary nutrient-management program in the nation and that regulations would be harmful to their industry and would not improve water quality. In addition, farmers noted that Maryland never gave them the opportunity to voluntarily address phosphorus runoff. They also indicated that the state was unfairly focusing its nutrient runoff concerns on them because they were a minority and it was cost-efficient, when other nutrient sources (e.g., wastewater treatment plants, development and urban runoff, septic systems, industry, golf courses, airports) were not similarly scrutinized. Finally, farmers contended that the water-quality-related threats linked to agricultural nutrient runoff, especially ES runoff, were exaggerated and did not reflect sound science.

Representatives of Delmarva Poultry Industry, Inc. (DPI) and Maryland Farm Bureau (MFB) voiced concerns over nutrient-management regulations to state government officials and legislators. DPI and MFB representatives made the case that Maryland needs to put its farmers' nutrient-runoff contributions to the bay in context with other nutrient sources, and measures to address nutrient concerns should include all nutrient contributors. They argued, for example, that more than half of the nutrient loads to the bay come from nonagricultural sources like urban and suburban point- and nonpoint-source pollution (particularly from development and wastewater treatment plants), and agriculture should not have to shoulder the costs for reducing bay nutrient levels for everyone.

Agricultural industry representatives noted that the ES is only 5 percent of the bay watershed and contributes a small portion of the nutrient loads to the bay (Satterfield 2007). For example, a U.S. Geological Survey report showed that three of the nine major rivers that drain into the bay (Susquehanna, Potomac, and James), none of which are located on the ES, account for about 95 percent of total nitrogen and 87 percent of total phosphorus loads to the bay (Belval and Sprague 1999). In comparison, the report indicated that the Choptank River, the largest river on the ES and one of the nine major bay watershed rivers, contributes less than 1 percent of the total nitrogen and phosphorus loads to the bay from the nontidal part of the bay basin. Other sources suggest that the ES's nutrient contribution is only 9 percent of the total nitrogen and 11 percent of the total phosphorus entering the bay (Blankenship 2007b). Moreover, industry representatives argued that Maryland's sole focus on agriculture to reduce bay nutrient levels was misguided and unfair. Furthermore, Maryland's regulatory efforts would jeopardize farmer livelihoods and threaten the ES poultry industry's ability to be competitive in national and international markets, while doing little to improve bay water quality.

Despite farmers' and other agricultural interests' significant opposition to nutrient-management regulations, environmental interests capitalized on the momentum behind the public's concern over the *Pfiesteria* threat and passed the Water Quality Improvement Act of 1998.

Maryland's Water Quality Improvement Act of 1998 and Nutrient-Management Regulations

Maryland's Water Quality Improvement Act of 1998 (WQIA) is among the nation's most comprehensive laws to reduce nitrogen and phosphorus runoff from farms (Blankenship 1998; Burkholder and Glasgow 2001; Simpson n.d.). The cornerstone of the act requires all agricultural operations with annual incomes greater than $2,500, or more than eight animal units (one animal unit equals 1,000 pounds live weight), to implement a nitrogen- and phosphorus-based nutrient-management plan (NMP) developed by a certified nutrient-management specialist. NMPs were to be developed and implemented between December 31, 2001, and July 1, 2005, depending on type of fertilizer applied (Simpson n.d.). The act also calls for a system of fines for noncompliance, specific record-keeping practices, certification to apply fertilizer, access to farms to check nutrient-management records, soil-fertility tests, nutrient analyses of organic fertilizers, and appropriate nutrient-storage procedures. The WQIA gave the Maryland Department of Agriculture primary oversight authority to implement and enforce the act, and with the assistance of the governor's Nutrient Management Advisory Committee (NMAC), MDA drafted the regulations that implement the WQIA. After a lengthy public commenting period on the draft nutrient-management regulations (NMRs), MDA published the final version of the regulations in 2000 (COMAR n.d.a, b, c, d, e; Maloney and Paolisso 2006; MGA 1998; Simpson n.d.).

Nutrient-Management Regulations

At the heart of Maryland's nutrient-management regulations (NMRs) is the requirement that farmers develop and implement a nitrogen- and phosphorus-based nutrient-management plan (NMP). In general, NMPs are a planning document prepared by a certified nutrient-management consultant or certified farm operator that indicates how a farmer should annually manage the use of nutrients for crop production and for the protection of water quality. NMPs contain nutrient recommendations for crop production that are based on expected (realistic) yield goals; crop nutrient needs; existing soil-fertility levels; nutrient value of organic fertilizers (if used); placement, timing, and application of nutrients; environmental protection (i.e., risk of nutrient runoff); and other agricultural practices such as liming, tillage, and crop rotation (COMAR n.d.d, e). In addition, NMPs address all agricultural practices that relate to the "identification, management, and disposition of all primary nutrients produced on, imported to, and exported from the agricultural operation" (COMAR n.d.d:15.20.07.05A3b). Moreover, farmers are required to submit an updated NMP every three years, as well as a yearly "end of cropping season" report that summarizes completed plan activities and any plan changes that occurred each season (COMAR n.d.d).

Of particular concern to farmers are nutrient-management regulation (NMR) provisions that relate to nutrient-application rates and yield-goal determinations, which affect the amount of nitrogen and phosphorus that can be applied to crops. In general, NMRs require that nitrogen- and phosphorus-application rates be determined by a host of factors, including crop nutrient needs as stipulated by University of Maryland (UMD) crop nutrient recommendations (MDA n.d.; Coale 2002), realistic yield goals, soil analyses, nutrient loss risk assessments, and the nutrient analysis of any organic fertilizers used (COMAR n.d.e).

In the following sections I describe the regulatory requirements for and scientific process of determining nitrogen- and phosphorus-application rates. It is my intent to illustrate the inherent complexity and uncertainty in making these scientific determinations and to set the stage for comparisons in subsequent chapters of how these state-mandated processes and procedures mesh with farmers' understandings of nutrient-management decision making.

Nitrogen Use Determinations. If nitrogen-application rates are not limited by soil-test results showing excess phosphorus (discussed below), NMRs require that nitrogen application be based on practical, realistic yield goals that are achievable given favorable growing conditions (Coale 2002; COMAR n.d.e). Farmers must calculate expected yield goals in one of the following ways:

1) An average of the three highest-yielding years for the crop out of the latest consecutive five-year cropping sequence;

2) If yield information exists for more than five years for a given field or management unit, crop yield calculations may be based on the average of 60 percent of the highest-yielding years for all consecutive years that crop yield information is available; or

3) If field or management unit-specific yield or plant production goal information is unavailable or unrepresentative . . . any soil productivity information [can be used or] the average yield based upon an average of the three highest-yielding years for the crop out of the latest consecutive five-year cropping sequence from nearby fields or management units with similar soil type and management conditions [can be used] (COMAR n.d.e:15.20.08.05C1-2).

Phosphorus Use Determinations. Even though NMRs link nitrogen-application rates to yield goals, the NMR requirement that farmers conduct soil tests prior to planting to determine the levels of phosphorus and other nutrients (not nitrogen, see MCE 1995) in soil samples influences the type (organic or inorganic) and composition (ratio of nitrogen to phosphorus) of fertilizer that can be applied. Thus, one function of conducting soil tests is to determine whether phosphorus levels are high enough to limit the use of certain fertilizers (like poultry manure) that contain a higher proportion of phosphorus to nitrogen. For example, crops need approximately five times more nitrogen than phosphorus. Organic fertilizers like poultry manure result in the application of three to four times more phosphorus than the crop requires, which may increase the risk of phosphorus runoff (Coale 2000; Staver and Brinsfield 2001).

Soil-test findings are expressed as numeric values that describe the "relative availability of a given nutrient to the crop and the expected crop response to application of that nutrient to the soil" (Coale 2002:2). The Maryland

Cooperative Extension Soil Testing Laboratory's (MCESTL) soil-test results fall into four interpretive categories: low, medium, optimum, and excessive. In brief, low suggests that there would be a favorable economic response to nutrient additions; medium, that there would be low to moderate favorable economic response; optimum, that there would be a very low favorable economic response; and excessive suggests that nutrient additions would be unprofitable and could adversely affect crops (Coale 1996, 2002).

In addition, according to the NMRs, if soil-sample results show a phosphorus fertility index value (FIV) of less than 150, nitrogen plant needs can be used as the limiting factor when applying organic fertilizers that contain a higher phosphorus to nitrogen ratio (COMAR n.d.e). Like MCESTL's soil tests, the FIV is another method to express relative levels of available crop nutrients from soil tests. "Fertility index values comprise a continuous relative scale that is calculated from the concentration of extractable nutrients measured in the laboratory, where the highest concentration within the 'optimum' range is set equal to fertility index value of 100 (FIV = 100)" (Coale 2002:2). Like the MCESTL categories, the FIV scale also has four similar interpretive categories: low (0-25), medium (26-50), optimum (51-100), and excessive (> 100) (Coale 2002, 2005a, 2005b; MCE 2001).

However, if phosphorus FIV is 150 or greater, NMRs require that a phosphorus site index (PSI) be used to determine the risk of phosphorus loss (COMAR n.d.e). The PSI is a procedure that uses "characteristics of soils, landforms, and management practices to identify potential risk of phosphorus losses from soils to waters" (COMAR n.d.e:15.20.08.03B30). More specifically, the PSI is comprised of two parts: site characteristics (Part A) and source and management characteristics (Part B). Part A evaluates six site characteristic factors that could cause phosphorus loss: 1) soil erosion, 2) soil runoff class, 3) subsurface drainage, 4) leaching potential, 5) distance to surface water, and 6) watershed priority ranking. And Part B evaluates five phosphorus loss factors due to management practices, soil tests, and source characteristics: 1) soil test phosphorus, 2) planned phosphorus fertilizer application rate, 3) phosphorus fertilizer application method and timing, 4) planned organic phosphorus application rate, and 5) organic phosphorus application method and timing (Coale 2002, 2005a, 2005b; MCE 2001).

The PSI uses these 11 factors to evaluate a specific location and assigns each factor a numeric value. The sum of Part A (multiplied by a scaling factor of 0.02) can be interpreted as "the proportion of the [phosphorus] source present at the site that is susceptible to being transported off of the field by drainage water and impacting adjacent surface waters" (Coale 2005b:2). The sum of Part B, multiplied by the sum of Part A, is the final phosphorus loss rating, which is subdivided into four interpretive categories: low (0-50), medium (51-75), high (76-100), and very high (> 100). Sites with a "low" rating predict less phosphorus loss than those in the "medium" category, and sites with a "medium" rating predict less phosphorus loss than sites in the “high” category, etc. (Coale 2005b).

Therefore, according to the NMRs, the higher the PSI score the greater the restrictions placed on phosphorus use, as well as organic fertilizer used to meet nitrogen and phosphorus plant needs (COMAR n.d.e). For example, if the risk is “low,” nitrogen plant needs can be the limiting factor when using organic fertilizer. If there is a “medium” risk, nitrogen plant needs can be used as a limiting factor one out of every three years. The other two years phosphorus rates should be limited to expected crop uptake or the amount indicated by soil testing that is needed, whichever is greater. Approved best-management practices (BMPs) can also be implemented to address site or management characteristics that would reduce the risk to “low” and allow nitrogen plant needs to be the limiting factor. If the risk of phosphorus loss is “high,” phosphorus rates should be limited to crop uptake or the amount indicated by soil testing that is needed. If BMPs are implemented that reduce the risk to “medium,” nitrogen plant needs can be the limiting factor one out of every three years. The other two years phosphorus rates should be limited to expected crop uptake or the amount indicated by soil testing that is needed. Finally, if the risk is “very high” according to the PSI, no additional phosphorus can be applied. However, if BMPs can be used to reduce the risk to “high,” phosphorus rates should be limited to expected crop uptake or the amount indicated by soil testing that is needed (COMAR n.d.e).

Organic Fertilizer Analyses. In addition, NMRs also require those farmers who use natural organic fertilizers (e.g., animal manure, biosolids, green manure, compost) to determine their nutrient value before application (COMAR n.d.e). Calculations for nutrient content of these organic sources must consider "mineralization rates and plant availability rates for different forms and sources of organic nutrients" (COMAR n.d.e:15.20.08.05F6). For example, Maryland Cooperative Extension figures suggest that for broiler manure, "an average of 50% of the organic nitrogen mineralizes the year of application, with 15% mineralizing the year after application and 8% the second year after application" (MCE 2006b:9-10). In contrast, phosphorus in organic manure is completely plant-available the year of application (ibid.:11). However, these estimates may vary because "the rate of mineralization is affected by temperature, moisture, soil chemistry and time" (SDCE 2003:2). Finally, in determining organic nitrogen-application rates for any one season, NMRs require that the amount of organic nitrogen that has mineralized from the two previous years of application must also be accounted for in one's nitrogen calculations (MCE 2006b).

Relative Nature of Test Scores and Regulatory Allowances. Even though soil tests and FIV values provide a scientific means to assess a soil's fertility status, they "do no provide a direct measure of the actual quantity of plant available nutrients in the soil" (Coale and McGrath 2006:1). Instead, soil tests are "products of laboratory procedures that determine the concentrations of extractable plant nutrients [using a particular chemical extracting solution] in a measured volume of soil" (Coale 2002:2; Coale and McGrath 2006:1), and FIV values express relative levels of available crop nutrients from soil tests (Coale 2002). Similarly, manure analyses also do not predict actual levels of available nutrients, and PSI loss ratings are not a quantitative prediction of actual phosphorus loss from specific fields (Coale 2005a). In essence, soil-test, FIV, manure-analysis, and PSI values are relative, arbitrary index numbers.

Moreover, despite the relative, arbitrary value of nutrient-application determinations, farmers may not exceed recommended nutrient-application rates and must follow all other nutrient-management plan (NMP) requirements. There are, however, some instances where farmers can deviate from their NMP's nutrient-management recommendations. For example, farmers may make adjustments to these recommendations if the following occurs:

> A condition beyond the control of the operator, including a natural disaster, unanticipated weather condition, animal mortality, or disease; or [due to] unanticipated conditions, such as market changes or economic factors that may cause modification of the agricultural operation, or other limitations, such as equipment calibration limits, or limits on the availability of commercial fertilizer blends to reasonably meet nutrient management recommendations (COMAR n.d.d:15.20.07.05C1a-b).

This allowance is subject to considerable scrutiny. Any nutrient-management recommendation adjustments still must be consistent with NMP criteria and must conform to MDA and UMD recommendations for growing a particular crop in a certain soil with a specific fertility level and realistic yield goals (COMAR n.d.d).

Thus, an emergency in-season allowance may be granted or tolerated but is not expected to be repeated.

Implementation and Enforcement of Nutrient-Management Regulations

Given farmers' fierce opposition to Maryland's NMRs, several MCE and MDA representatives I interviewed feared farmers would not comply with new mandated NMPs. In addition, they were also worried that the trust and cooperative working relationship that they had built with farmers over many decades, which had been fundamental to their success in garnering farmer support for numerous voluntary agricultural programs, was severely damaged because of the state's decision to regulate them. According to these representatives, this threatened their ability to get farmers to voluntary participate in other important agricultural programs not related to NMRs. Agency representatives were particularly concerned about whether farmers would meet NMP development and implementation deadlines. The following are WQIA deadlines for developing and implementing NMPs based on the type of fertilizer used:

December 31, 2001
1) Develop and submit an NMP for both nitrogen and phosphorus for chemical fertilizer users.
2) Develop and submit an NMP for nitrogen for biosolids or animal manure fertilizer users.

December 31, 2002
1) Implement NMP for both nitrogen and phosphorus for chemical fertilizer users.

2) Implement NMP for nitrogen for biosoldids or animal manure fertilizer users.

July 1, 2004
1) Develop and submit an NMP for both nitrogen and phosphorus for biosoldids or animal manure fertilizer users.

July 1, 2005
1) Implement NMP for both nitrogen and phosphorus for biosoldids or animal manure fertilizer users (COMAR n.d.d).

MCE and MDA representatives noted that if farmers chose not to meet the 2001 and 2002 WQIA deadlines, their decisions were more likely to be a statement of protest than a result of their inability to comply. As a MDA representative explained in a July 2000 interview, failure to comply with these deadlines would be a form of protest because farmers already demonstrated under Maryland's voluntary nutrient-management program that they could develop and implement nitrogen-based NMPs. MCE and MDA representative were concerned, however, about farmers' ability to comply with 2004 and 2005 WQIA phosphorus-based requirements. Farmers had not previously used and experimented with phosphorus-based NMPs, and MCE and MDA representatives were afraid farmers would not implement them if they proved too costly as a result of not being able to use cheap phosphorus-rich poultry manure for fertilizer.

Concerns over farmer compliance were validated when only 20 percent of eligible farm acres met the first WQIA deadline, delay forms were filed for 44 percent of farm acres, and no response was given for the remaining 36 percent of farm acres (Herbst 2005). In part, a lack of MCE resources for NMP writing support created a backlog of more than a 1,000 assistance requests which hampered farmer compliance (ibid.). Farmers' limited NMP submissions and low compliance, however, was most likely a calculated form of protest against NMRs. I say calculated because many of the LES farmers I interviewed suggested that Maryland's mandated nutrient-management program would not have the resources to adequately enforce the regulations. Given the controversy surrounding them and the newness of the program, MDA would probably not attempt early enforcement measures, particularly if many farmers were non-compliant. MDA nutrient-management program administer Fred Samadani, in a 2002 interview with Herbst (2005), described farmer response to the first deadline, MDA's reaction, and the context surrounding MDA's decision not to pursue enforcement measures:

> The law was approved with . . . limited time for farmers to understand the law and . . . the requirements and commitments. There was some resistance; sometimes it was very hard. When the first deadline came, 5,400 out of 9,000 operators had not responded to the deadline. We had to send a letter to them . . . we received a lot of negative responses and resistance, and also some farmers expressed fear of the laws and regulations. The department was in a situation that it found out it cannot penalize such a large majority immediately, because they were not prepared. Also the agriculture community, the farm bureau and other institutions, they were strongly resisting the program in their annual meetings and in the meetings that they had here with department representatives. They were criticizing the department and so on. After I sent the letter in June 2002 to operators and we got those reactions, the Secretary of Agriculture told us to halt on enforcement of regulations. Also, November 2002 was the election year--they were discussing these issues and the administration changed. The new administration met with the

> agriculture community and promised to streamline the program and listen to them.

MDA found itself in a difficult situation, trying to enforce a law that was so widely opposed by its constituents, as well as the larger agricultural industry, with limited resources and the sense that a new gubernatorial administration might alter regulatory requirements in the near future. Also, given MDA knowledge of previous farmer program participation, it is my sense from interviewing MCE and MDA representatives and farmers that MDA probably believed it would take several years to get the mandated program up and running, and their time would be best spent trying to facilitate farmer participation through education and technical assistance rather than enforcement. In fact, it was not until 2005 that MDA began to enforce the submission of NMPs (Herbst 2005; MDA 2006). And it took a new Republican administration elected in 2002 to spearhead legislative efforts to eliminate the "right of entry" language in the NMRs and to reduce and streamline paperwork requirements before farmer NMP compliance would significantly improve. In addition, it was not until 2006 that MDA first started to check NMP implementation by inspecting about 10 percent of eligible farms (MDA 2007). In the fall of 2007, MDA widely reported that it would begin ramping up its enforcement efforts to bring remaining noncompliant farms into compliance (NASDA 2007).

Moreover, farmer NMP compliance and farms under NMPs since December 2001 have been, at best, difficult to determine (Herbst 2005). Until

2005, compliance was determined by submission of an NMP (which is good for three years), a delay form indicating that an NMP would be submitted within a year, and the filing of an updated NMP in cases where seasonal adjustments to the original plan were necessary. In 2005, delay forms were no longer allowed, and the requirement that farmers submit plan updates at the beginning of the season and in-season as they happen was changed to filing an abbreviated annual implementation report (AIR) covering activities for the previous season by March 1 of each year. Thus, before 2005, it was difficult to determine the accuracy of MDA's compliance figures because there was no way to gauge how MDA accounted for outdated NMPs and delay forms in their totals (not to mention the number of farms that might be noncompliant because they did not file yearly updates to reflect seasonal changes or simply did not implement part or all of their plans). These adjustments could make a significant difference in the number of farm acres reported under NMPs because acreage under noncompliant NMPs would no longer be included. Since 2005, it has also been difficult to determine from MDA calculations if outdated NMPs, and those that have not been accompanied by AIRs, are accurately accounted for in compliance figures and total acreage under NMPs.

What is clear, however, is that given farmers' significant interest and participation in Maryland's voluntary nitrogen-based nutrient-management program, farmers should have been capable of (and even interested in) meeting the 2001 and 2002 deadlines for submitting and implementing nitrogen-based

NMPs. Nevertheless, MDA reported that only 20 percent of eligible farm acres were put under mandated NMPs by the end of 2001. And by the end of 2002, only 45 percent of eligible farm acres were enrolled. Despite low enrollment, the overall compliance rate was 64 percent in 2001 and 83 percent in 2002 because filing a delay form maintained one's compliance. For 2003 and 2004, MDA reported that farm acreage under NMPs increased to about 70 percent, but that delay forms and "no responses" each accounted for about 15 percent of eligible farm acres. Still compliance rates were 80 percent or better. Interestingly, compliance rates dropped in early 2005 despite farmer-welcomed revisions to the WQIA and NMRs taking effect during that period, the elimination of delay forms, and a new March 1 deadline for filing AIRs and delinquent NMPs. MDA reported that only 43 percent of farm acres were under NMPs and compliant by the March 1, 2005 deadline (Blankenship 2005; Herbst 2005). However, by the end of 2005, MDA (2006) reported NMPs on 80 percent of farmland (1.2 million acres). Finally, MDA reported in 2006 that 94 percent of farm acres affected by the WQIA were under NMPs, and in 2007, 98 percent (MDA 2007, 2008a). By April 30, 2008, MDA reported AIRs for 2007 (due on March 1, 2008) had been received for 89 percent of eligible acres covered by law (MDA 2008b).

Current State of the Chesapeake Bay

Behind Maryland's concerns over *Pfiesteria* and agriculture's nutrient contribution to the bay was the desire to achieve the year-2000 goal stipulated in the 1987 Chesapeake Bay Agreement to reduce nutrient contributions to the bay by 40 percent of 1985 levels. Despite progress made by bay partners in improving water quality, only 80 percent of the nutrient-reduction goals were achieved by 2000 (OIG 2006). This prompted Virginia; Maryland; Pennsylvania; Washington, D.C.; EPA; and the Chesapeake Bay Program to sign *Chesapeake 2000*, a new more ambitious agreement to restore bay health by 2010 (CBP 2000; OIG 2006). The 2000 agreement indicated that improving water quality is the most critical element in bay restoration and nutrient and sediment overloading is the primary cause of bay water-quality degradation (OIG 2006, 2008). To restore bay health by 2010, the 2000 agreement set the most numerous and specific restoration goals to date in the areas of living-resource protection and restoration, vital-habitat protection and restoration, water-quality protection and restoration, sound land use, and stewardship and community engagement (CBP 2000). An important function of the 2000 agreement is to improve the water quality of the bay and its tributaries so they can be removed from EPA's list of impaired waters by 2010. If this goal is not accomplished these water bodies will be subject to EPA's total maximum daily load (TMDL) requirements that will set enforceable pollution levels for them (OIG 2008).

2010 Goals Not Achievable Due to Poor Bay Health

EPA has acknowledged that nutrient-reduction and bay-restoration goals will not be met by 2010 because rates of improvement will fall significantly short of target goals.

> For example, based on EPA/CBPO estimates of nitrogen reductions between 1985 and 2004, loads decreased at a rate of 3.4 million pounds annually. However, meeting the Bay loading goals by the 2010 deadline would require a reduction rate of 16 million pounds of nitrogen each year from 2004 to 2010 (OIG 2006:14).

In fact, EPA notes that it could take decades to achieve target reductions and even longer to reach ecological-restoration goals. In the example above, EPA suggests that it would take 28 years to reach the 2010 nitrogen goal at the reduction rate of 3.4 million pounds annually (OIG 2006). Achieving that goal may be even more time consuming than reported because the remaining reductions may prove to be more challenging than those previously obtained (OIG 2006, 2008). The following EPA findings summarize current bay health and nutrient- and sediment-reduction concerns:

> At the current rate of reductions, it will take decades to meet the 2010 goals. Based on the 2007 health and restoration assessment in *A Report to the Citizens of the Bay Region* issued by the Chesapeake Bay Program partnership, the Bay partners have achieved 47, 62, and 64 percent of the nitrogen, phosphorus, and sediment loading goals, respectively. These decreases are primarily the result of reductions from upgraded wastewater treatment facilities, successful phosphate detergent bans, and use of agricultural best management practices. Based on monitoring data, the U.S. Geological Survey determined that nitrogen and phosphorus concentrations have decreased but not at a rate that

> would sufficiently reduce nutrient loads to meet the Bay's water quality standards by 2010. In 2007, the Bay partners reported that they were only 21 percent of the way toward meeting the water quality goals, a drop from 23 percent in 2006 (OIG 2008:8).

The same EPA report highlights specific issues that continue to plague bay health:

> Nutrient and sediment runoff have harmed bay grasses and bottom habitat, while disproportionate algae growth has pushed the bay food web out of balance. Bay habitats and lower food web are at about one-third desired levels. Many of the bay's fish and shellfish populations are below historic levels. The blue crab population has been below management targets for the past 10 years. Fish and shellfish are at about two-fifths of desired levels (OIG 2008:3).

EPA suggests that the biggest challenges now facing nutrient reductions to the bay have to do with uncontrolled land development, limited implementation of agricultural conservation practices, and limited control over air emissions (OIG 2008). In fact, development is increasing nutrient and sediment loads at rates faster than restoration efforts are reducing them (OIG 2007, 2008). Perhaps the biggest challenge to bay restoration, however, is funding. The Chesapeake Bay Program estimated in 2004 that $28 billion would be needed to implement tributary strategies necessary to achieve 2010 goals (OIG 2008).

Role of Agriculture in Current Bay Health

EPA and Chesapeake Bay Program (CBP) states have identified agriculture as the single largest contributor of nutrients and sediment to the bay. Bay watershed model estimates in 2007 suggest that agriculture is responsible for

40 percent of nitrogen, 46 percent of phosphorus, and 60 percent of sediment loads to the bay (OIG 2008). As a result, Chesapeake Bay states have committed the agricultural community to achieving 65 percent of nitrogen, 60 percent of phosphorus, and 86 percent of sediment load reductions needed to meet 2010 goals (ibid.). One reason agriculture has been given the lion's share of reduction responsibilities is because EPA, USDA, and CBP partners have determined it is the pollutant source that can achieve the greatest reductions at the least cost (OIG 2006). For example, in comparing nitrogen-reduction strategies for agriculture, point sources, urban runoff, and septic systems, EPA and USDA scientists found that for 13 percent the cost of all other strategies, agriculture could achieve 64 percent of all nitrogen reductions needed (ibid.). Nevertheless, monetary challenges exist because states estimate that over $2 billion ($651 million for Maryland) are needed to implement the required agricultural practices (ibid.).

According to the 2007 CBP watershed model estimates, nutrient loads from the agricultural sector since 1985 continue to decline, but the reduction is not enough to meet 2010 water-quality goals. More specifically, the agricultural sector has achieved 48 percent of its nitrogen-reduction goal and 51 percent of its phosphorus-reduction goal, leaving significant reductions to be obtained in the three remaining years leading up to the 2010 goal (OIG 2008). Reductions to agriculture's bay nutrient loads have been attributed to the implementation of BMPs. However, there is little, if any, quantifiable evidence to demonstrate that any one BMP or combination of BMPs, conservation or environmental program, or voluntary or regulatory approach is responsible for nutrient-reduction gains (including insufficient gains).

Bay scientists estimate that agriculture contributes 57 percent of nitrogen and 55 percent of phosphorus loads from the LES to the bay (BayStat 2007). Despite its large contribution, the LES agriculture sector has achieved 69 percent of its nitrogen and 82 percent of its phosphorus reduction goals. In comparison, from all sectors, the LES has met 57 percent of its nitrogen and 78 percent of its phosphorus reduction goals (ibid.). In addition, as of 2004, LES tributary-strategy goals have been met and exceeded for implementation of BMPs such as nutrient-management plans, conservation tillage, and retirement of highly erodible land. Also, implementation is high (approximately 75 percent or more of goals) for animal waste-management systems, soil-conservation and water-quality plans, forest buffers, and tree plantings on agricultural lands (MDNR 2007a). As is the case with the bay in general (OIG 2008), LES water quality seems to have improved little from agricultural nutrient-load reductions and increased conservation activities. According to a LES tributary report: "Only scattered improving trends in water quality are seen in the Lower Eastern Shore, and many areas remain in poor condition, especially with respect to suspended solids and clarity. . . . No improving [nitrogen] trends are seen throughout the basin . . . [but] phosphorus is improving in many locations" (MDNR 2007a:iii).

If agriculture is the major contributor of nitrogen, phosphorus, and sediment to the bay, and it has significantly reduced its nutrient contributions to the bay and has increasingly adopted conservation measures to improve water quality--all since 1985--then serious questions need to be raised as to why greater baywide water-quality improvements have not been obtained. Legitimate questions would address the accuracy of the tools designed to measure bay water quality, the extent to which pollution sources have been appropriately identified and the effectiveness of strategies designed to reduce their contributions, the degree to which pollution-reduction strategies are being implemented, and the limitations of our ecological and biological understandings of the bay watershed. As an example of the latter, *Pfiesteria* has yet to reappear in bay waters on the deleterious scale it did in 1997. In fact, no significant adverse aquatic or human-health effects have been attributed to *Pfiesteria* in bay waters since 1997.

Chapter 6

Farmers' Cultural Model for Grain-Farm Management

Farmers' strong opposition to regulatory measures to reduce nutrient runoff and limited participation in Maryland's voluntary nutrient-management program signaled to environmentalists that they were not concerned about protecting the environment and must be forced to change their nutrient-management practices. They believed that farmers were motivated by profit and were not willing to adopt more eco-friendly nutrient-management practices because that would increase their costs and reduce their profits. As a result, many environmentalists decided that if they wanted to improve water quality, the state had to mandate nutrient-management practices. A final significant view shared by environmentalists and a good number of agricultural researchers was that farmers lacked the agronomic and ecological knowledge needed to make appropriate nutrient-management decisions. Thus, nutrient-management regulations were viewed as necessary to reduce nutrient runoff because farmers did not understand the complex scientific knowledge required to grow crops and protect the environment.

Given the above, it is tempting to accept that regulating farmers' nutrient-management practices is the only reasonable and justifiable approach to reduce agriculture's nutrient-runoff contribution to the bay. However, my research suggests that the picture portrayed above is incomplete, and that a more comprehensive understanding of farmers' shared beliefs and behaviors would significantly challenge regulatory proponent's general views about them. I found that grain farmers share a cultural model for grain-farm management that sharply contrasts with regulatory proponent's general understanding of their nutrient-management-related beliefs and practices. This cultural model helps to explain grain farmers' ardent opposition to nutrient-management regulations. In addition, this cultural model not only provides a critique of Maryland's nutrient-management efforts; it also highlights policy- and program-relevant measures that can be taken to increase grain-farmer support for policy and program efforts. In this chapter, I present grain farmers' cultural model for grain-farm management and provide a detailed discussion of its core components and relationship to their understandings of nutrient-management regulations.

Data that comprise this cultural model come from comments made by Lower Eastern Shore (LES) farmers in interviews and at nutrient-management hearings. More specifically, data come from farmers who currently produce grain or have previous grain-farm experience. Some of these farmers just produce grain, grow grain and raise poultry, or only raise poultry. In the case of the latter, some are retired grain farmers, grain producers who switched to poultry, or poultry growers who were raised on grain farms and actively participated in all production activities through early adulthood. From this point forward, I use "farmers" and "grain farmers" interchangeably when discussing my LES grain-farming target group and their cultural model for grain-farm management.

Table 6.1. LES Grain-Farming Target-Group Members Quoted.

	Age	Type of Production	Acres Farmed	Poultry Houses
Key Informants				
Stephen Borg	≥ 45	Grain/poultry	50 to 179	3 to 5
Tom Carter	≥ 45	Grain	≥ 1,000	0
Patrick Casey	≤ 44	Grain	≥ 1,000	0
Elmer Henkle	≤ 44	Grain/poultry	50 to 179	2
Gary Knight	≥ 45	Grain/poultry	180 to 499	2
Donny Mueller	≥ 45	Poultry*	0	6 to 8
Rodney Rademann	≤ 44	Grain	500 to 999	0
Greg Schaffer	≤ 44	Grain/poultry	500 to 999	3 to 5
Mike Williams	≤ 44	Grain	≥ 1,000	0
Others				
Mary Engels	≥ 45	Poultry**	0	3 to 5
Nick Haus	≥ 45	Grain	50 to 179	0
Earl Johnson	≥ 45	Grain/poultry	50 to 179	2
Danny Leery	≥ 45	Grain/poultry	50 to 179	3 to 5
Bobby Marshall	≥ 45	Grain/poultry	50 to 179	2

*Previously owned and operated a grain farm.
**Raised on a grain farm and participated in all production activities.

When possible and applicable, I illustrate grain-farmer understandings and cultural-model components with representational farmer quotes from interviews and nutrient-management hearings. Because of their ability to articulate their beliefs and values, as well as capture those of other LES grain farmers, I draw heavily on quotes from the nine key informants I introduced in Chapter 4. To protect the anonymity of these key informants and other target-group members I quote who live in the small, tight-knit LES farming community, I edited out any identifying markers from the passages I reference. In addition, I refer to these farmers only by pseudonyms and the limited personal data I provide in Table 6.1 above. Given these farmers' prominence in their communities and readily identifiable histories and farm characteristics, providing additional descriptive information would unnecessarily jeopardize their anonymity, which I promised to preserve. Also, there are several instances where I quote Maryland farmers who are not a part of the LES grain-farming target group because their comments at nutrient-management hearings succinctly capture those of target-group members.

A more comprehensive discussion of cultural-model theory was presented in Chapter 2. Here it is important to restate that not all cultural-model knowledge is completely implicit and out of the conscious awareness of its knowledge holders (D'Andrade 1995; Strauss and Quinn 1997). I mention this because the levels of implicitness and explicitness varied for farmers' cultural model for grain-farm management. Nevertheless, the model presented below is inherently implicit for two fundamental reasons: 1) farmers would find it nearly impossible to fully describe it without considerable prompts and probing, and 2) much of farmer cultural knowledge about the model and its components and relationships is based on lessons learned from experience. It is difficult to state in abstract terms, although farmers recognize the cultural model once it is articulated. The cultural model is what they know so well that they feel it does not need to be articulated. It is just obvious--a matter of fact, natural and right--though again they would not be able to communicate well the complete model and its parts and relationships.

I do not claim that this cultural model represents all aspects of farmer understandings about grain-farm management.[1] I do argue, however, that the cultural model elicited captures some of farmers' core cultural understandings about grain-farm management. These understandings provide a cognitive framework that allows them to make and evaluate production decisions in the context of changing environmental, market, and policy conditions, all the while sustaining practices, beliefs, and values that underlie their identity and way of life. Below I provide an ethnographic account of farmer beliefs and understandings about grain farming--including those exemplified by farmer views on nutrient-management regulations--that make up a cultural model for grain-farm management.

In one final note, I drew from the work of many cognitive anthropologists discussed in Chapter 2 in creating farmers' cultural model for grain-farm management. Nevertheless, Michael Paolisso's (2002) cultural model for blue-crab management was particularly influential in how I constructed this farm-management model.

Cultural Model for Grain-Farm Management

I present a cultural model for grain-farm management in Figure 6.1 below. Each of the model's components and relationships is described in greater detail in the following sections. Here, I provide a brief description of the cultural model, which will help organize and frame the following data. As shown in Figure 6.1, farmers' grain-farm management model has three major components or subcultural models: “production environment,” “farm-management strategies,” and “farm-management goals.” Within each of these components, there are more specific schemas that are represented by the use of farmer propositions (e.g., “nature is unpredictable”) or by ethnographer statements (e.g., “make tradeoffs and allowances”), which in turn represent a series of propositions or schemas farmers have about, in this case, the need for farms to make tradeoffs and have allowances, given the complexities and uncertainties of grain farming.

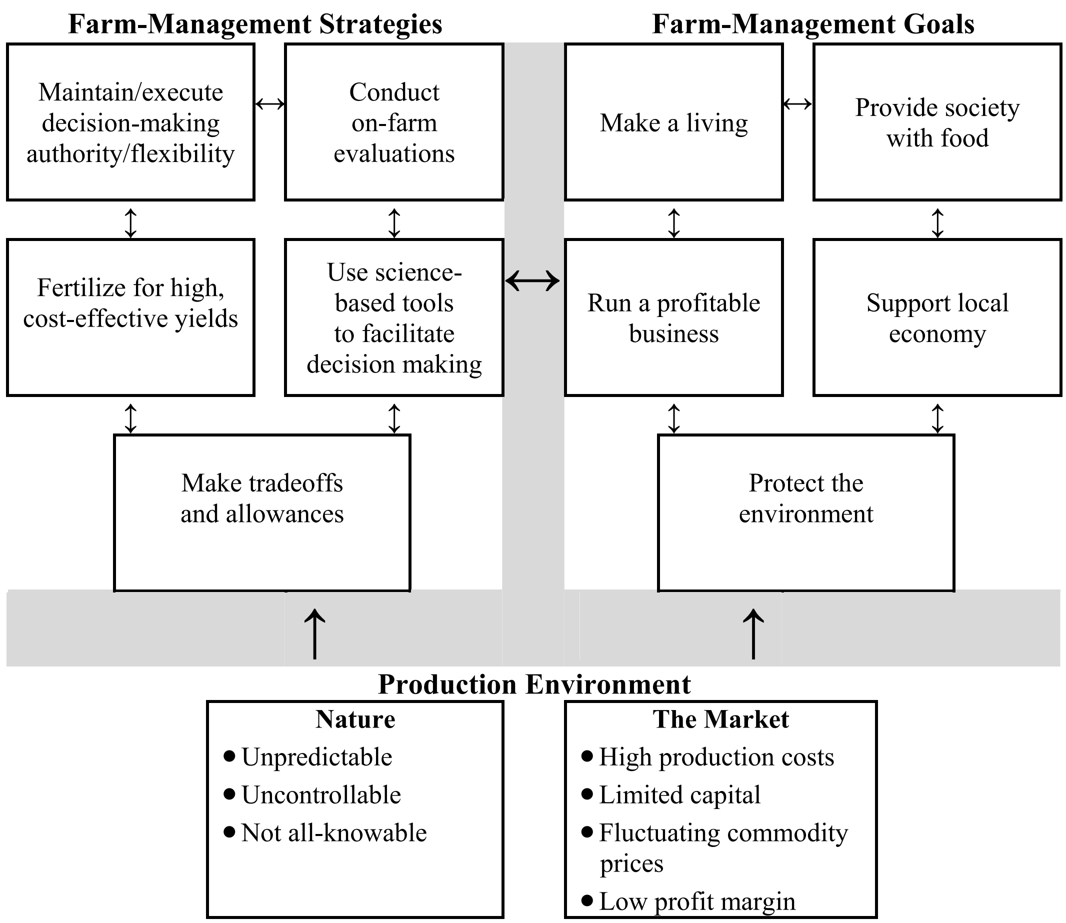

Figure 6.1. A Cultural Model for Grain-Farm Management: “Nothing is Perfect.”

For ease of presentation, I use the simplified schematic of farmers' cultural model for grain-farm management shown in Figure 6.1 to describe farmers' cultural and experiential knowledge about the grain-farming process. The model represents a production environment--consisting of natural and market processes--that shapes both farm-management strategies and goals, which in turn influence each other. Because of the challenges posed by the production environment, grain farmers require a suite of interrelated farm-management strategies to best meet their farm-management goals. It consists of beliefs and practices that involve making tradeoffs and allowances; maintaining and executing decision-making authority and flexibility; using science-based tools to facilitate decision making; fertilizing for high, cost-effective yields; and conducting on-farm evaluations. These farm-management goals include: "make a living," "run a profitable business," "support local economy," "provide society with food" and "protect the environment." Farmers mentioned many goals they strive to achieve as an outcome of their grain-farm management, but these five are particularly relevant to nutrient-management discussions. As is the case for farm-management strategies, their farm-management goals are also interrelated.

In the remainder of this chapter, I expand on the elements of the farm-management model presented in Figure 6.1 by providing ethnographic data on the specific processes, beliefs, and practices within the model's components of "production environment," "farm-management strategies," and "farm-management goals." Before providing that description, it is important to briefly explain a broader cultural schema that encompasses the cultural model for grain-farm management, which is captured by the widely shared farmer proposition that "nothing is perfect."

In interviews and during participant observation, farmers repeatedly emphasized that their grain-farm-management practices must be understood within a context that is best described as "nothing is perfect." As Patrick Casey put it, "nothing is perfect; we're not perfect; and that's life" (January 23, 2001). This proposition that "nothing is perfect" has its roots in farmer knowledge of and experience with the dynamic complexities inherent in the grain-production process. The key production and management variables that drive much of their decision making and evaluations are, to a significant degree, filled with uncertainty and imperfect or incomplete knowledge. For example, patterns of rainfall and temperature during the growing season, changes in prices for farm inputs and outputs, and changes in state policies are all factors over which grain farmers have limited, if any, control and predictive knowledge. These limitations and uncertainties make grain farming a risky and imperfect enterprise. Moreover, grain farmers' belief that "nothing is perfect" is the accepted reality from which they determine their farm-management strategies and goals. As a result, the "nothing is perfect" proposition permeates and influences all aspects of grain farming, creating a domino effect of influence among the core components of their cultural model for grain-farm management.

Finally, I offer three brief observations to guide the reader through the description of farmers' grain-farm management model. First, most of the following sections provide general information on farmers' beliefs and practices, followed by a closer situation of those beliefs and practices vis-à-vis Maryland's nutrient-management regulations (NMRs) and mandated nutrient-management plans (NMPs). Thus, the sections provide both general and more specific information on farmers' cultural model as well as the details of their grain-farming practices and NMPs. Second, the description of the farm-management goals represented in Figure 6.1 is embedded in the discussion of the production environment and farm-management strategies. In interviews and observations, these goals were most clearly articulated by farmers as they described some aspect of the production or management environments. Third, the three components of the cultural model are closely interrelated, and farmers often explain multiple aspects of the cultural model at the same time. Thus, the following descriptions include some natural overlap, where, for example, a description of beliefs about the production environment also includes references to farm-management strategies and goals.

Production Environment

The production environment of the cultural model for grain-farm management consists of two key submodels or components: 1) the natural environment and 2) the market. Grain farmers characterize the natural environment as unpredictable, uncontrollable, and not all-knowable; and they associate the market with high production costs, limited capital, fluctuating commodity prices, and low profit margins.

Natural Environment is Unpredictable and Uncontrollable.

> I can't control Mother Nature; nobody can. I can't, the weatherman can't, and college doctorate degree people can't; nobody can (Rodney Rademann, April 20, 2001).

Grain farmers' proposition of "nothing is perfect" extends to their understanding of nature and how it affects their ability to farm and make a living. As a result of farmers' experiences living and working closely with nature, they have acquired the belief that nature is unpredictable and that an important part of grain farming is learning to accept and work with these natural environment limitations to make a living. As Gary Knight explained:

> Mother Nature is unpredictable, and it can change quickly because of the unpredictability. But, when you work around it all the time, when you've farmed as many years as I have, you just come to accept the fact that you're going to have good years, bad years, droughts, and floods. You just kind of roll with the flow with it. For some people who just get into farming and have a couple of bad years, they might get discouraged about it and blame the weather. But, when you've farmed a long time as I have and my father and grandfather have, you just realize that bad weather is just part of farming (April 24, 2001).

Farmers' references to nature typically referred to weather conditions, and the fact that they have no control over the type of weather they get, as well as when they receive it. This is problematic for grain farmers because they are dependent on favorable weather conditions to accomplish time-sensitive production tasks and produce high-yielding crops. “We rely solely on Mother Nature. And if Mother Nature doesn't work with you, then you're lost” (Greg Schaffer, December 13, 2000). Farmers note that grain farming is particularly risky because despite their best efforts to produce a good crop, nature will ultimately determine the outcome of their efforts. Farmers argue that you can be one of the best grain farmers in the nation with a state-of-the-art production plan, the most fertile soil, and the most technologically advanced equipment, but poor weather conditions can still cause you to lose everything. Mike Williams describes the extent to which nature controls the outcome of grain farmers' production efforts:

> I'll use this explanation about Mother Nature out of respect for what she can take from you and what she can give you. Last year [2000], because of the weather conditions, we probably had the best growing season we've had since I've been farming with my father since the early ‘80s. On the other hand, back in the early '90s, I wanted to try a new crop called canola. And I planted canola on a 100-acre farm. It was two days from harvest and a hailstorm came through and devastated the entire crop, and we harvested basically nothing. So I had taken a risk with a new crop and probably had $20,000 invested in it. And because of one storm one evening, I got nothing. And then the exact opposite of that is last year [2000], we could do nothing wrong and everything we had came up wonderfully. So those are two examples that I've lived through where weather gives it to you or takes it away from you and you have absolutely no control over it (April 19, 2001).

In talking about nature's ability to “give it to you or take it away from you,” farmers frequently described nature's unpredictable disposition.

> Mother Nature can be the best friend in the world and give you rain exactly when you need it and nice temperatures and no wind blowing when you want to spray and everything goes fine. And at other times, she can be your worst enemy and produce hail that destroys your wheat crop, or big floods of rain that come the day after you plant your soybeans and flood everything out, and then you have to wait two weeks and go back and replant it all. . . . It's really a gamble (Rodney Rademann, April 20, 2001).

As Mr. Rademann explains, weather affects crop production in a variety of ways over the course of the production season. Using corn production as an example, farmers indicate that rain levels, wind conditions, and temperature significantly influence the production process.

> Farming is awful tricky and that's what people just don't realize. We can sit here and make the nicest business plan and draw out how it will work, but the first rain or freeze can change everything and cause you to chuck it out the window and start over (Mike Williams, April 19, 2001).

Beginning in early March, farmers have to the end of the month (maybe the first part of April) to "work-up" (i.e., till) any fields that need it, apply herbicide to "burn-down" any cover crops or weeds before they can plant, spread fertilizer, and generally prepare their fields for planting. Spreading manure alone can take several weeks. Frequent March rains can prevent farmers from working in their fields, and windy conditions can stop them from spaying herbicides, all of which push back their planting.

> It rained about the whole month of March and I couldn't get into the field to do anything. You need decent dry weather to spread manure. You can't get out there after you've had a couple of

> inches of rain because your spreader is heavy and you will get stuck. Now I'm here in April trying to spread manure (Patrick Casey, January 23, 2001).
>
> When you're spraying, you're not supposed to do it when the wind is blowing. That protects you as well as everybody else. If the wind is blowing 20 miles an hour, all your spray starts drifting off your property. So spraying is a real challenge to do if you try to do it when the wind is not blowing and it's dry enough to get on the field and do it when they're calling for rain within 48 hours. And if you don't get the rain, sometimes it doesn't work. And then three or four weeks later you have a bunch of grass and weeds coming back up in your field and you have to go back and spray again (Rodney Rademann, April 20, 2001).

Once farmers have successfully prepared their fields for planting, they have about a month (April to mid-May) to plant and fertilize (i.e., inorganic fertilizer) corn. It can take a full month to plant a 1,000 or more acres of corn. Farmers need to get their corn in the ground as early as possible, but no later than mid-May, to ensure that it pollinates during mid-June, early-July rains. Hitting or missing this key rain period can easily make a 50-bushel-an-acre difference in yield. Rain-soaked fields and low ground temperature can delay planting and threaten yields. And once corn is planted, farmers gamble that nature will provide the rain it needs to grow.

After corn has reached maturity in late summer, farmers need dry weather so the corn's moisture content can be reduced to an acceptable level to harvest. The price they receive for their corn is docked for every half percent their corn moisture content registers above 15.5 percent. Finally, starting in late September, farmers need dry fields to harvest. Corn needs to be harvested before stalks fall to the ground. Wind and rain can bring corn down and mud can keep combines out of the fields.

"Nothing is perfect" is an apt descriptor for farmers' imperfect ability to create and implement production plans that allow them to achieve time-sensitive production tasks with desired results and produce high, cost-effective yields. Personal experiences, and the related belief that nature makes grain farming an imperfect enterprise, help explain farmer resistance to nutrient-management regulations. In the quote that began this section, Rodney Rademann, reflecting the views of other LES grain farmers, expressed his opposition to regulations by saying that nobody can control nature. Mr. Rademann and others argue that excess nutrient runoff is largely a function of nature, and they cannot be held responsible for preventing it when they cannot control the natural processes that cause it. Farmers repeatedly told me that despite their best efforts, normal to heavy rains will cause nutrient runoff.

> We can't control Mother Nature. When you put your fertilizer down and all of a sudden you get a seven- or eight-inch thunderstorm, it's going to run off. There's nothing we can do about that (Gary Knight, December 14, 2000).

> We have absolutely no control over the environment, and that's what people don't understand about these regulations. If I go out here today and put on fertilizer for my corn and I get a thunderstorm this evening that washes 50 percent of that as surface water runoff into the ditches, which goes into the streams, which goes into the rivers, which goes into the bay, I can't control that (Mike Williams, April 19, 2001).

Many farmers I interviewed said that one reason regulatory proponents may be so supportive of mandated nutrient-management practices to reduce nutrient runoff is their belief in man's ability to control nature. They argued that regulatory proponents were primarily from urban areas where their ability to manage and manipulate their highly developed environment led them to believe that the rural farm environment would be equally pliable. Farmers noted that urban beliefs about man's ability to control nature are not applicable in rural areas. As Mike Williams explained:

> Mosquitoes are a given on the Eastern Shore. Sometimes they are good, sometimes they are bad. You live with them. These people come in from the city and think, "Oh, my God, I have these mosquitoes." They think that there is some secret spray the state can use or something that they can buy that will rid their property of mosquitoes. That doesn't happen. But, because they felt like they had control of their little quarter acre in the city, they think they can control where they are now. The city is controlled by people. And here, people are controlled by Mother Nature; whether it is a flood, snow, rain, or mosquitoes. We live with Mother Nature. In the city, they live with people, and the people control. Here we have a traffic jam when a tree blows across the road. There they have a traffic jam everyday because of people (August 8, 1998).

Moreover, many farmers I interviewed said that differences in views over the degree to which man can control nature may explain why staunch nutrient-runoff reduction advocates fail to fully comprehend the inevitability of some nutrient runoff.

Even though grain farmers believe they cannot prevent nutrient runoff that occurs from unfavorable weather conditions, they still feel it is their responsibility to use best-management practices (BMPs) and technology derived from the best-available science to prevent excess nutrient runoff. However, farmers argue they cannot afford to adopt those eco-friendly practices and technologies that are not cost-effective and do not allow them to make a living. Thus, as long as farmers continue to use the best practices and technology available to them that are cost-effective, they do not consider themselves to be polluters if their actions result in nutrient runoff:

> You can't control Mother Nature. If you have a big flood after you put fertilizer and chemicals on, some of it will wash off. That's just the way of life. I mean, how can you get around that? Farmers will use the best techniques they have and the latest science [that are cost-effective (as explained earlier in the interview)]. What more can I do? We're going to have some pollution; I don't care what you do. If you drive your car you have pollution. So, as long as were doing the best we can with the technology, we never really consider ourselves as polluters. You know, anybody who drives a car doesn't consider themselves a polluter in that same aspect. Farming has made major changes every decade, and it's always improved every decade. It's improved as far as efficiency, and it's a lot more environmentally friendly. So, being a polluter is just not in our vocabulary. And runoff is just an act of God (Gary Knight, April 24, 2001).

Farmers believe that nutrient runoff beyond levels that can be mitigated by the implementation of reasonable nutrient-reduction measures is either an act of God (or nature) or the result of their imperfect ability to make a living that causes no adverse effects, given the challenges posed by natural and market forces.

Not all Nature is Knowable. In response to questions about the linkages between *Pfiesteria*, water quality, and nutrient runoff, farmers frequently commented that attempts to understand these issues were valuable, but because they deal with nature they will never be fully understood. According to these farmers, not everything about nature can be explained:

> I'm not an educated man, you know? I'm not claiming to know anything about the scientific aspect of this [*Pfiesteria* and nutrient runoff]. But I have enough education to know one thing; you can't explain everything about Mother Nature. But in this day and age, everything has to have an explanation. And I disagree with that. I don't think everything necessarily is to be explained (Patrick Casey, January 23, 2001).

Grain farmers note that scientific understandings of nutrient runoff are also incomplete. They believe science cannot determine and account for all the natural variables that influence nutrient-runoff levels.

> Our scientific knowledge [about nutrient runoff] is not there. . . . We have a [nutrient runoff] survey project going on in Wicomico County and they are finding out that there are certain things that are inherent in a lot of their [previous] calculations that are problematic. They are finding out that when nutrients may be high or low, it may be a tree that has fallen over and decaying in a small stream. There are spikes and stuff that are in the water sampling and they have to level all that out. And it's somebody's best damn guess. . . . Also, it's hard to single out certain areas [to study] because you can get it too big or too small. They had a large area they were doing research on, but apparently the area was too large because they couldn't control everything that was coming in. In some situations they kept lowering their nutrients and doing it by best-management practices, but their nutrient levels still kept increasing. They were taking more and more yield off and they weren't applying more fertilizer, but nutrient levels were still increasing in the watershed. Nature has funny ways (Tom Carter, August 5, 1998).

Farmers are skeptical about the accuracy of scientific findings. Adding to this skepticism is their observation that scientists frequently cannot reach consensus on their findings and that these findings regularly change over time. As Earl Johnson explained:

> Scientists are often not sure about things. Half often feel differently about a finding. I don't know if they know what the hell they are talking about half the time because half of the scientific community feels one way about something and the other half feels differently (August 5, 1998).

Farmers say these disagreements often result in scientific findings that repeatedly go in and out of favor, leaving them with unclear guidance on how to proceed. They told me how scientific understandings of crop and poultry production have dramatically changed over the last 40 years--in terms of cultivation practices, fertilizer and pesticide types and application rates, seed types and placement, and farm equipment. Thus, many grain farmers said they are reluctant to adopt new scientific findings and practices that have not stood the test of time because their experience suggests that they will change and may prove to be disadvantageous. As Tom Carter told me: “Things that I have seen that are supposed to be the wave of the future 20 years ago, my God, today, that's the worse thing that could ever happen” (January 5, 2001).

Maryland’s *Pfiesteria* controversy and nutrient-management debate gave farmers an ideal opportunity to witness the uncertain and changing nature of scientific understandings as they relate to phosphorus runoff, the role of nutrient runoff in causing toxic *Pfiesteria*, and the relationship of toxic *Pfiesteria* to fish kills in bay waters. Farmers reported hearing changing scientific views on what promotes *Pfiesteria* growth; heated scientific debates over whether fish kills were actually caused by *Pfiesteria*, *Pfiesteria*-like organisms, or other natural phenomena; and conflicting scientific views among soil scientists about the extent of phosphorus mobility in the soil profile.

> I know what they told us as soils majors, not to worry about phosphorus because it's locked up in the soil profile and it's not going anywhere. But that science has changed. When's this phosphorus site index [new tool to assess phosphorus mobility] going to change? When is research from the University of Maryland going to come out and change something else? This is Pandora's Box, guys. . . . I'm concerned we're going to make rash judgments based on the data that we collect from incomplete science. And that's a dangerous thing (Kenny Bounds, MidAtlantic Farm Credit, Easton, Maryland, MDA nutrient-management regulations hearing, February 24, 2000).
>
> Well, as I know right now, the University of Maryland is the only one that has really come out and took a stance on this soluble phosphorus. There's really no other university that's going out and saying it is such a detrimental part to our waterways. . . . It's hard to see how so many scientists at so many universities over so many years are so wrong about phosphorus not moving in the soil (Mike Williams, January 10, 2001)

In summary, farmers argue that nature is at best difficult to understand, and that scientific knowledge of its systems and processes will always be incomplete and uncertain, leading to findings that are debated and frequently change. As a result, grain-farmer production decisions and practices will always be based on imperfect natural environment knowledge. And the outcome of these decisions and practices will have the potential to produce less-than-desirable effects that farmers have a limited ability to control.

Market Environment. Along with the challenges posed by unpredictable nature and incomplete knowledge, grain farmers argue that a combination of market factors constrain their farm-management strategies and goals. These market factors include high production costs, limited operating capital, fluctuating commodity prices, and historically low profit margins. As with unpredictable and unknowable nature, these market constraints contribute to making grain farming an imperfect undertaking.

<u>High Production Costs</u>. Farmers argue that the high cost of agricultural production makes grain farming very challenging because it requires a high rate of return to cover costs and make a living. Farmers suggest that the competitive, capital-intensive nature of conventional grain farming is largely the result of market forces and government policies that have required farmers to increase the scale, mechanization, productivity, and economic efficiency of their farms to meet food demands and stay profitable. As a result, farmers have a significant investment in land, machinery, and equipment and have considerable long-term debt. It is not uncommon for full-time grain farmers to have a million dollars or more invested in their farms. Farmers also reported that conventional grain farming requires increasingly expensive production inputs like seed, fertilizer, pesticides, and fuel.

> This year [2001] is probably going to be one of our lowest years ever for commodity prices. And our input costs are probably going to be our highest ever. They're expecting diesel fuel to be in the $1.30 to $1.40 range by the time tillage season starts and right now I think it's around a $1.15 or $1.20. So they're expecting it to rise. In the meantime it's jumped 10 cents in the last two weeks (Greg Schaffer, April 26, 2001).

> This year [2001] alone, our nitrogen costs have just about doubled. And with commodity prices we're talking probably 20 percent less this year than they were last year, and last year was extremely low (Elmer Henkle, April 17, 2001).

Limited Capital. Because production costs are high, grain farmers regularly obtain short-term loans to pay for yearly input costs. These loans can become difficult to service if farmers experience a year or two of low profits. Farmers' loan payments are based on expected average returns, which make it difficult to meet debt obligations in years of low returns. In addition, if farmers are carrying debt from previous years of poor returns, it is more difficult to acquire production loans for the current season. And if new production loans cannot be obtained, farmers' cumulative debt obligations make it difficult to use their own money to finance the current season. Thus, grain farmers' debt load, along with high seasonal production costs, increases the risk of going out of business. As Greg Schaffer explained:

> You might see some farmers go down this year [2001] if we have a hot, dry summer, because they just got by on the skin of their teeth last year. And they're probably carrying over some debt from last year or from previous years (April 26, 2001).

Fluctuating Commodity Prices. **A**nother challenging aspect of grain farming is fluctuating commodity prices. Commodity prices change from month to month, season to season. Farmers are never certain what prices they will receive at harvest and have to gamble that they will be high enough to cover their expenses and make a living. Also, they argue that even though they may be able to produce a good crop, there is no guarantee that they will receive a good price. As Nick Haus explained, "This past summer [2000] we had wonderful crops and terrific yields, but the prices were so poor" (January 26, 2001).

Grain farmers are not entirely at the mercy of fluctuating commodity prices, however. For example, they can forward contract some or all of their crops, which in theory guarantees them a predetermined price at a negotiated delivery date. This date can be at harvest, or another predetermined time. In the case of the latter, farmers can store their grain in bins or silos (their own or rented) after harvest to hold for sale at some future date. Farmers exercise the forward-contracting option with the hope that the contracted price will be higher than the one they might receive if they sold their crops at harvest on the open market, or at another negotiated time.

Even though forward contracting can be advantageous, it is not risk free. For instance, forward contracts require farmers to deliver a certain quantity of product at a specified date, and if they have a poor or late harvest and cannot meet the terms of their contracts, they are penalized and receive a smaller return. This amount may be considerably less than what they would have made if they sold their crops at harvest on the open market. In some cases, farmers may actually owe money to their contracting companies. In addition, farmers who store their grain with the hope of selling it in the spring or summer when grain prices typically rise due to supply shortages are also subject to financial risk. For example, a combination of grain surpluses that reduce prices and the cost of grain storage (off-farm: rental, drying, and handling fees; on-farm: structure, equipment, and electricity costs) over time can significantly affect profits. Thus, despite the stabilizing and beneficial effects that forward contracting can provide, they are not guaranteed, and a combination of environmental and market forces still make commodity prices unpredictable.

Commodity prices have not only routinely fluctuated, they have remained chronically low in the process, which has made it even more difficult for grain farmers to make a profit. During the time of my research, farmers argued that commodity prices had been low for the past 15 to 25 years.

> The price of general agricultural commodities has not gone up in 25 years, and if anything it's decreased (Greg Schaffer, December 13, 2000).
>
> Agriculture is being hit pretty hard right now. We have all heard about how this economy has flourished in the past three or four years. Agriculture has not enjoyed that, at all. Commodity prices are at 15 to 20 year lows (Stephen Borg, January 4, 2001).

With historically low commodity prices and rising input costs, many grain farmers indicated that they could not survive without loan-deficiency payments (LDPs). When market prices for grain are lower than the government-set minimum, the government pays farmers the difference in cash as an LDP. These payments help farmers stay in business during years when market prices are exceptionally low. The grain farmers I interviewed noted that LDPs are no cure-all, and that some years these payments barely cover the cost of production.[2]

Record-high commodity prices in recent years may cause some to question the low-price trend noted by grain farmers and its effect on their bottom line. These price increases are deceptive, however, because production costs have also increased, reducing profitability. For example, fertilizer prices have risen 228 percent since 2000 (Hannah 2008), and seed prices are expected to rise 35 percent from the 2008 to 2009 season (Hotchkiss 2008). In addition, higher prices may still be relatively low in that they do not reflect inflationary adjustments.

Farmers argue that market forces and government policies have largely been responsible for historically low commodity prices. Farmers do not directly determine the prices of their commodities and cannot build increases in the cost of production into those prices. They not only sell their commodities at wholesale prices, which they do not set, but also pay retail for all their production expenses. As two grain and poultry farmers explained:

> Every time the farmer goes to sell it's always cheaper, and when he goes to buy it is always higher. The farmer never gets his share of profit. Everybody else can mark it up whatever they want to (Bobby Marshall, August 19, 1998).
>
> Farmers are the only people in the world that buy at retail and sell at wholesale. That's basically what we do. We buy a bushel of corn at retail for seed and we produce 400 from that and sell it

> wholesale. We really don't have a lot of control over our destiny as far as pricing (Stephen Borg, January 4, 2001).

Thus, even though grain farmers told me they do not like to receive LDPs, which they consider a form of welfare that carries negative connotations, they believe they must because our nation has a cheap-food policy that creates low commodity prices.

Low Profit Margin. Grain farmers consistently reported that theirs is a very challenging profession because of the low rate of return on their investment. They often argued that other industries would not invest in a business like grain farming because it has such a small profit margin. Mike Williams and Stephen Borg explained it this way:

> We have good years, but we have bad years. And this may be an average year [1998]. We're hoping it may be. We're looking at having a 5 percent return on investment on a million dollars. That wouldn't flow on Wall Street, but it flows on the family farm (Williams, August 20, 1998).
>
> I don't know of a single broker on Wall Street that would take the investment that I have here and look at the return and not sell it (Borg, January 4, 2001).

Academics, extension agents, policy makers, and others who work on agricultural issues confirm farmer comments about a low profit margin (Blank, Erickson, and Moss 2005; Doehring 2001; Edwards 2006; STAC 2004). The general consensus is that agricultural production has a low rate of return on farm assets (ROA) that averages between 3 and 6 percent in the U.S. (Blank, Erickson, and Moss 2005; Doehring 2001; Edwards 2006). More specifically, Blank, Erickson, and Moss (2005:216) report that the average ROA for agricultural production in the U.S. from 1960-2002 was 4.3 percent.

For the farmers interviewed, low grain returns make it exceedingly difficult to handle financial problems created from increased expenditures and consecutive years of poor performance. The Chesapeake Bay Program's Scientific and Technical Advisory Committee (STAC) concurs, indicating that grain farmers have to assess their survivability on a yearly basis because of their low profit margin (STAC 2004). Because of low returns, farmers are vulnerable to even small increases in production costs, as well as short-term financial losses. As noted by STAC (2004:18):

> Farm businesses have very little margin for any financial problems that may be created by resource protection practices or structures. It may take years to recover from short-term losses, and seemingly minor financial risks may significantly impact their ability to stay in business.

Farm-Management Strategies

The farm-management strategies component of the cultural model for grain-farm management presented in Figure 6.1 includes beliefs and practices about making tradeoffs and allowances; maintaining and executing decision-making authority and flexibility; using science-based tools to facilitate decision making; fertilizing for high, cost-effective yields; and conducting on-farm evaluations.

Make Tradeoffs and Allowances. In interviews, farmers noted that one reason they were so angered over Maryland's nutrient-management approach was because it did not recognize the imperfect nature of grain farming and the need for tradeoffs and allowances. Because grain farming is an imperfect and uncertain undertaking, farmers argue that they must make tradeoffs and allowances to make a living, contribute to the economic well-being of their community, and meet our nation's food needs. For example, since nature is uncontrollable and farmers must use nutrients to grow crops and make a living, allowances should be made for some nutrient runoff. As Tom Carter and Gary Knight explained:

> Last year it rained and it didn't quit raining. We had a monsoon on our sandy soil. Fertilizer goes away now. It either leached down into the groundwater or it went off into the stream. I don't have any control over that. If I want to make a profit, I still have to fertilize to produce a crop (Carter, January 5, 2001).
>
> You're putting nutrients on the ground to grow a crop. You get a big rain or something on there and it runs off. Now what else are you supposed to do? I mean, people have to eat (Knight, April 24, 2001).

Through decision-making processes that involve informal and formal cost-benefit analyses and risk assessments, farmers contend that everyone regularly makes decisions based on what they perceive to be acceptable levels of risk. Mike Williams explained it this way:

> When we go swimming in the Atlantic Ocean, sometimes we get an ear infection. Do you shut down the Atlantic Ocean for the 100 people that may get an ear infection this weekend? No, because you weigh the pros and the cons to it. So there has to be checks

> and balances and pros and cons weighed to determine that it's an acceptable risk that we have decided must be taken for the areas financial stability. I mean, there is acceptable risk in everything. We do it everyday. It is just acceptable. You know, you were just born to accept it (August 20, 1998).

Farmers made the case that the State of Maryland routinely makes decisions that trade off some level of environmental health for economic prosperity and community health and happiness: carbon dioxide pollution for power and transportation; nutrient discharges for wastewater treatment; destruction of environmental habitat for commercial, recreational, and residential development. Thus, grain farmers believed it was unreasonable and hypocritical for the state to deny them runoff allowances, given their production constraints and the importance of their work. As Mike Williams noted:

> I feel like you have to have an acceptable number [total daily load for nutrients] that the state comes up with that they're willing to accept for this industry and the income it generates because everything in life has a tradeoff. There's an accepted environmental impact for a sewage treatment plant. Now there has to be an accepted environmental impact to have agriculture in your area (January 10, 2001).

Farmers also brought up the point that even the state's no-till agriculture conservation initiative required them to risk one aspect of environmental health to improve another. For example, the state promoted no-till farming over traditional practices because the former is better than the latter in helping to prevent soil erosion that leads to sedimentation and poor water quality. Despite this environmental benefit, farmers say that the state's no-till campaign may be trading less sedimentation for increased levels of nutrient runoff. Because no-till practices do not incorporate nutrients into the soil like till farming does, nutrients remain on the soil surface longer and are more susceptible to overland flow. Tradeoffs between the two practices are even more complicated when other environmental, economic, and agronomic factors are considered. For instance, not only are plowed fields prone to soil erosion, but plowing is more time and fuel-intensive than no-till practices. But no-till farming creates less favorable seed beds and requires more chemical applications and costs to control weeds than tilling.

Moreover, the farmers I interviewed had an unwavering belief that the benefits derived from grain farming far outweigh any costs to bay water quality from agricultural nutrient runoff and warrant environmental tradeoffs and allowances.

> And they [state officials and environmentalists] have to understand that that [rain-related nutrient runoff] is the risk that they have to take for this economic machine of agriculture to operate. And I believe what they're giving up in environmental quality versus what they're getting in economic prosperity [on the Eastern Shore] is not even questionable. If you look at the economic gain that agriculture contributes to the area and the environmental harm that we're causing, it's not even close (Mike Williams, April 19, 2001).

> I mean, we're not producing a luxury item here; we're producing food and fiber, which is a necessity. It would be different if we were producing something cosmetic or something nobody really needed. . . . It's not like we're doing something here like golf courses that use fertilizers to make their grass look green (Gary Knight, December 14, 2000).

> I can't sit here and say the farmers don't pollute in a way. I know we do. We're putting chemical on the land to help grow plants. But, in the same token, I am sure that is poisoning something else. What's good for one plant may not be for another plant. I can't deny that. But, with anything, you have to weigh the costs, the benefits versus the losses. Are farmers supplying more benefits to this country and other countries in worldwide food production than what we are polluting or taking away? I believe we are (Rodney Rademann, January 23, 2001).

Maintain and Execute Decision-Making Authority and Flexibility. Because of the imperfect and dynamic nature of grain farming, and each farmer's unique production context, farmers argue that they need to maintain and execute considerable decision-making authority and flexibility to address the diverse farm-related challenges they confront. This means that grain farmers need decision-making freedom to create and alter their production plans, as well as a wide range of production options to select from and reconfigure, to meet the unique production challenges that they face every season.

> With today's [January 10, 2001] Chicago Board of Trade prices at $2.50, the most economical bushel per acre I can fertilize for is around a $1.80 for a 160-bushel-per-acre corn crop. That's what I'm going to shoot for. But if corn goes to $4.00 per bushel, it makes it economically feasible for me to shoot for 200 bushels per acre at a cost of $2.25 per bushel. That's the game I have to make a decision on, the price I'm going to get for the yield and the input cost. It's many other factors too, from seed population to chemical usage to timing of planting and timing of spring moisture conditions. Between three or four people I've got 1,000 acres of corn to plant in 30 days, which will take about two hours an acre to accomplish. We also have to make an assessment of whether we can no-till that field this year, which means we go in and plant it without disturbing the soil, or we have to till the field because of compaction. That's a $30 to $40 an acre decision that includes time, fuel, and wear on equipment. It's just daily decisions like

> these on every acre that I need flexibility to make. And whether I make the right decision or the wrong decision determines whether I stay in business or not (Mike Williams, January 10, 2001).

Thus, given grain farmers' understanding that they have limited control over many elements of the production process, combined with their belief that living everyday life necessitates imperfect decisions, they contend that it is unrealistic for the state to expect them to achieve 100 percent nutrient-management plan (NMP) compliance. Elmer Henkle illustrated it this way:

> There has to be a percentage factor that the state feels that they need to achieve to say this [nutrient-management plan compliance] is or isn't successful. We have a seatbelt law in Maryland. And I've heard the state say that if they can get 80 percent of the people to use seat belts then they feel like that's a success. Well, I feel like that if I follow my nutrient-management plan to 80 percent, then it has been a success. That this is the goal [100% compliance] and this is what it has to be or you will have to answer to Big Brother is really what has turned the agriculture producers off. I mean, give me a plan, tell me what I need, and allow me to try to achieve that goal the best way I can (January 5, 2001).

According to grain farmers, to achieve nutrient-management goals they need flexibility within their NMPs to vary their decisions and practices in unique ways to best meet them while adapting to changing production variables to make a living. Reflecting the views of other grain farmers, Mike Williams uses a map analogy to explain his need for decision-making flexibility:

> You can look at a nutrient-management plan as an atlas. An atlas shows you how to get from point A to point B. But, you have many different ways on that atlas you can achieve that. The nutrient-management plan needs to be the same way. It needs to

> show you how to get from point A to point B, but it also needs to give you the flexibility to take other routes to get there. And I'm not sure that this plan has that (January 10, 2001).

Regulations Take Away Farmers' Decision-Making Authority.

> Regulations will limit you if they require you to do the same thing on every farm. But I don't think that's the worst part. The worst part about the regulations is the fact that they're telling you that you have to do it. They're taking control of part of my operation. And it takes away my flexibility of varying how much fertilizer I use (Rodney Rademann, January 23, 2001).

One of farmers' chief complaints about Maryland's regulatory nutrient-management approach was that it "told" them what they could and could not do on their own farms. Farmers argue that regulations, through the threat of financial penalties and legal repercussions, force them to take certain actions. Reflecting many LES-farmer views on nutrient-management regulations, Mary Engels commented: "I don't like the government saying we must do this or else. I don't like government restrictions and being told what you can and cannot do with your land" (January 19, 2001). There are few things that agitate grain farmers more than being told how to farm. One senior Maryland Department of Agriculture (MDA) employee described it this way, "The concept of someone else telling farmers how much fertilizer they can put down just absolutely eats at them."

Aversion to policies and programs that dictate how to farm is not simply a superficial disdain for being told what to do, it is an expression of farmers' cultural understanding of what it takes to make a living farming. As the quote that opens this section suggests, grain farmers believe that nutrient-management regulations took away their decision-making authority and flexibility. Thus, by regulating farmers, Maryland effectively dismissed their understanding that grain farming is imperfect and denied them the one allowance they believe gives them the best chance to make a living: “We were given no allowance for our ability and our good judgment” (Calvert County farmer, Annapolis, Maryland, MDA nutrient-management regulations hearing, February 22, 2000).

The farmers I interviewed were adamant: they should have control over their farm-management decisions. No one else knows their land’s productive potential like they do, or what combination of practices is most likely to make their farms profitable. They have spent decades (often a lifetime) making a living from farming the same land and developing effective agricultural practices tailored to the unique needs, interests, and conditions of their farm operations. Some grain farmers told me that the very fact that they have remained in business over the years despite all the environmental and economic impediments they face proves that their agricultural knowledge and experiences are valuable.

Because the grain-production environment is volatile and farmers have a limited capacity to recover from short-term losses, they believe it is critical each season to secure the highest returns possible through decisions and practices that best reduce risk and maximize profit. Farmers argue they are the most qualified to make and implement these decisions and practices:

> The farmer knows his land. He knows what he's done in the past and knows what works. It's his best chance. He's the one that quits making money if he is wrong or if mandated practices fail. It's his money on the line (Tom Carter, January 5, 2001).
>
> I think what has happened with mandated nutrient-management plans is that a lot of farmers don't like somebody coming on their property that they've spent years to buy and pay for, devise successful agricultural practices, and make it profitable, and then have somebody come and tell them, "You're going to do it our way, not your way." And that's a hard pill to swallow, it really is. I know when somebody comes up here and tells me I've got to change things, and it's going to cost me to change them, I don't like it. Especially if it's somebody that doesn't realize how changing farming practices can affect farmers economically (Greg Schaffer, December 13, 2000).

Use Science-Based Tools to Facilitate Decision Making. Even though grain farmers are adamant about basing their production decisions on their own knowledge and experience, they are also strong advocates of using scientifically derived, decision-making tools and production practices. As Donny Mueller said about the role of science in making farm-management decisions, "It's a step along the way, but it's a big step" (April 18, 2001). As the quote suggests, farmers believe that findings derived from science-based decision-making tools are valuable in making production decisions. Farmers told me that they greatly value and regularly use science-based production tools like NMPs, soil fertility tests, manure tests to determine nutrient levels, and crop-specific nutrient-application rate recommendations. They argue, however, that they are imperfect decision-making tools that need to be built upon because they at best approximate real-world conditions. Farmers further contend that they are not sufficiently comprehensive to account for, integrate, and manage the full range of production variables that must be considered in grain farming.

Given farmers' belief that science-based decision-making tools are valuable but limited, they argue that science should not govern their farm-management decisions. This belief is the basis for one of farmers' major objections to nutrient-management regulations, which they feel is premised on letting scientifically derived nutrient-management plans (NMPs) govern their farm-management decisions. According to farmers, this understanding implies that scientific measures are capable of generating all of the agronomic knowledge that they need to produce a certain commodity, protect the environment, and make a living. As a result, farming becomes a formulaic process that simply requires the implementation of a scientifically derived production plan.

> Nutrient-management plans are not something where you open a book and you solve for X, Y, and Z and you have the answer. It's more like you have a plan that helps you solve for X, Y, and Z (Mike Williams, January 10, 2001).
>
> Mandated nutrient-management plans are a realm of paperwork. Not that there couldn't be good things come from it. You know, soil testing and manure testing are good things. But you have to build on those things to make a proper decision. It's not like balancing a checkbook or depositing money into a bank account. We're living and producing in a nature type thing and there are too many variables there that you can completely account for in much of this nutrient-management thing (Elmer Henkle, January 5, 2001).

In opposition to the science-governed decision-making approach represented by Maryland's nutrient-management regulations, Elmer Henkle commented: “I still believe agriculture to be a little more art than it is science” (January 5, 2001). This statement is an apt descriptor of grain farmers’ belief that their professional judgment is central in making farm-management decisions, which include those pertaining to nutrient use. Thus, farmers contend that they must use their own agronomic knowledge and experience as their ultimate decision-making tool and guide to determine what combination of their own, scientific, and other knowledge best suits their production environments and needs. As Greg Schaffer explained:

> You base your operation on the knowledge that you have gained over the years. And I've learned a lot from older farmers. They taught me, and a lot of what they taught me still applies today. But what we've had to do now is take the knowledge that we have from the new scientific end and mix it with our knowledge that we've picked up over the years. You have to work them both together; you can't go just one way or the other. And you come up with your own little special blend of what you think will work and what won’t work. You can't go totally on one person's knowledge (December 13, 2000).

In addition, many farmers expressed dismay over the fact that agricultural policy is being shaped by scientists and policy makers who claim to be experts in some area of agriculture but have little real-world understanding of what it takes to grow commodities and run a profitable business. Farmers argue that there is significant difference between the knowledge needed to grow crops and reduce nutrient runoff and the knowledge required to make a living doing it.

> First of all, it seems to me that not everybody knows computers, not everybody knows automobiles, and not everybody knows

> organic chemistry, but if anybody has planted a flower or grew a garden then they believe that they're an expert in agriculture. And I don't understand that. I don't understand how people feel that way. The perception is that farmers are substandard in education compared to the group that seems to be overseeing them, and that's not the case at all. If the facts were known, 99 percent of those overseeing farmers that consider themselves agriculture experts couldn't make a living farming, because there's so many day-to-day decisions that have to be made like this (snaps fingers) that aren't in a textbook that you really can't explain until you're put in that situation (Mike Williams, January 10, 2001).

> Most agricultural scientists are in their own world. They don't understand the concept of real-world farming and they're working on a research situation where they may need 10 or 15 pounds of fertilizer for their whole plot. And we have questioned some of them about whether it was practical or economical or sensible to do a certain procedure, and they'd say, "Well, that's not my job to determine that. My job is to say whether it works or it doesn't work." Some don't have good sense (Elmer Henkle, April 17, 2001).

By not allowing grain farmers the decision-making flexibility to draw on their own knowledge and experience to determine nutrient-application rates, farmers repeatedly argued that nutrient-management regulations take away their most valuable decision-making tools. They believe that the inflexible nature of mandated NMPs has put them in the unenviable position of having to be law breakers if they want to make production decisions that they believe are appropriate to produce healthy crops and necessary for their survival, but run counter to regulatory requirements.

> If I'm strapped with going by the nutrient-management plan, and I think I need to add more fertilizer using my best judgment, and I've looked and I've already applied what the plan has allowed me, and I put it out, then I become in violation of that plan. How am I

> going to defend myself when I'm trying to do what's right as far as being a farmer and producer, and what's right to produce good crops, and then in the long run protect the environment, too? I don't see anywhere in this program where I can use what I consider to be my good judgment, and all the experience I've accumulated over the years, all the experience that's been passed on to me. You've taken that ability away from me. Nutrient-management plans are a great tool to use along with everything else. But by making them mandatory you have tied my hands. I'm probably going to either catch a negative economic hit because of them or be in violation of them. That really concerns me. I want to do what's right. I've always wanted to do what's right; like just about everybody here. But we are strapped with this thing being mandatory, and it takes away what I think is our most important tool. You've shackled our ability, our experience. And I don't think we were given credit for them, and that really grates me. And it should grate every farmer in this state that we've been treated this way. We were given no allowance for our ability and our good judgment (Calvert County farmer, Annapolis, Maryland, MDA nutrient-management regulation hearing, February 22, 2000).

A final example of farmer views on the usefulness of science involves Maryland's nutrient-management regulatory requirement that grain farmers conduct a soil fertility test as a part of their mandated NMPs. This scientific test, performed by certified professionals, is used to determine soil nutrient levels, which factor into the determination of the type and amount of nutrients farmers are legally allowed to apply to their crops. Farmers argue that this scientific tool at best only approximates production environments.

Specifically, soil tests produce numerical values that describe the "relative availability of a given nutrient to the crop and the expected crop response to application of that nutrient to the soil" (Coale 2002:2). Soil test results are expressed in terms of their fertility index values (FIVs), which "comprise a continuous relative scale that is calculated from the concentration of extractable nutrients measured in the laboratory, where the highest concentration within the 'optimum' range is set equal to fertility index value of 100 (FIV = 100)" (Coale 2002:2). The FIV scale falls into four interpretive categories: low (0-25), medium (26-50), optimum (51-100), and excessive (> 100) (Coale 2002, 2005a, b; MCE 2001). In brief, low suggests that there would be a favorable economic response to nutrient additions; medium, that there would be low to moderate favorable economic response; optimum, that there would be a very low favorable economic response; and excessive suggests that nutrient additions would be unprofitable and could adversely affect crops (Coale 1996, 2002). Soil test results are significant because they determine phosphorus-application rates, and whether manure (used by most farmers as a cheap source of fertilizer), which contains a high concentration of phosphorus (P) to nitrogen (N), can be used to meet both crop N and P needs. As a general rule, crops need approximately five times more N than P. Thus, if organic fertilizers like poultry manure are used to meet crop nitrogen needs, it can result in the application of three to four times more phosphorus than required. This over application may increase the risk of phosphorus runoff (Coale 2000:47; Staver and Brinsfield 2001:860-861). If soil test results show a FIV of 150 or greater, a phosphorus site index (PSI) analysis is required to establish the risk of phosphorus runoff (COMAR n.d.e). As a result of high FIVs and PSI analyses, it is likely that farmers will lose at least some of their ability to use manure.

Grain farmers told me that soil tests and related PSI analyses are valuable farm-management tools, but they often produce results that contradict their own understandings of phosphorus runoff and plant available P. In terms of phosphorus runoff, many farmers' personal experiences suggest that, despite high P levels in their fields, P is not being lost to the extent that some Maryland scientists and policy makers claim. As Mike Williams explained:

> It's hard for a farmer to understand how phosphorus is leaving his fields. Phosphorus placement on a corn plant is critical. You can't get phosphorus to move in this soil out here two inches. It's because it attaches itself to soil particles. And if I'm two inches off on my fertilizer placement on a corn crop, it's very visible in the plant. You cannot get it to move. I can go in a field where I placed phosphorus last spring, it went through all the rain last summer, it went through a tremendous corn crop, and I've gone in there and planted wheat today, and where I put that phosphorus that wheat is still going to be taller than where it wasn't. It's hard to see how so many scientists at so many universities over so many years are so wrong about phosphorus not moving in the soil, and the visible aspect that we see is also wrong (January 10, 2001).

In addition, farmers contend that one result of phosphorus being bound to soil particles is that it is frequently not available for plant use. They said their fields can test high for phosphorus, but because it is locked in the soil (or beyond reach in the case of early growth) their crops cannot access it. And if they do not apply additional phosphorus, their crops will be nutrient deficient and low yielding.

> When you take a soil test, the phosphorus is extremely high. I've been applying 20/20/20 fertilizer for over 20 years on the farm and I have high phosphorous levels. But phosphorus doesn't go

> anywhere, it stays put. And what phosphorus is plant available and what's in the ground are two very different things (Howard County farmer, Westminster, Maryland, MDA nutrient-management regulations hearing, March 9, 2000).
>
> The other thing is these phosphorus tests. For those of us that have had nutrient-management plans before and have been trying to follow them, sometimes the results we get from growing our crops don't look like those tests to determine how much phosphorus is in the soil were right. Phosphorus is a little bit funny; it's not quite like nitrogen in the soil. We might test high for phosphorus. How much of the phosphorus on these tests is available for that particular crop we're growing? I have fields that test high, very high, for phosphorus, but if I don't put any phosphorus out there, you can see that in the crop. So, it's a problem there if you follow your nutrient-management plan. It concerns me that I'm going to be limited by that (Calvert County farmer, Annapolis, Maryland, MDA nutrient-management regulations hearing, February 22, 2000).

Farmers commented that the state's belief that phosphorus FIV scores of 51 to 100 are optimum and do not require additional P is problematic because it is well below many of their P soil-test levels and does not always match their understandings of plant-available P. For example, farmers noted that some of their fields have an FIV-phosphorus score of 150--the level that triggers a PSI analysis--or more, and still need additional P to grow crops. Thus, they argue that because soil test and PSI results often do not reflect their production environments, they need to draw on their own farm-specific agronomic knowledge and experience to determine nutrient-application rates.

Moreover, farmers are aware that soil tests "do no provide a direct measure of the actual quantity of plant available nutrients in the soil" (Coale and McGrath 2006:1). Instead, soil tests are "products of laboratory procedures that determine the concentrations of extractable plant nutrients [using a particular chemical extracting solution] in a measured volume of soil" (Coale 2002:2; Coale and McGrath 2006:1), and FIVs express relative levels of available crop nutrients from soil tests (Coale 2002). Thus, farmers believe that their own judgment, which contextualizes soil-tests results within their farm-specific knowledge and experience, is the best and most comprehensive farm-management decision-making tool to assess soil fertility levels.

Fertilize for High, Cost-Effective Yields. Grain farmers say they need high yielding years over time to compensate for poor commodity prices, high production costs, and previous years of low yields and returns. They argue that they need the freedom to fertilize for maximum, cost-effective yields when conditions warrant it because high yielding years are pivotal to their survival. Farmers say they must fertilize for above average yields if there is a chance for good growing conditions because a missed opportunity could make a significant difference in their ability to remain in business. As Stephen Borg explained: "If I don't put down fertilizer for a good yield, and we have rain, I won't get the yield I need. So you lose that potential" (January 24, 2001).

Maryland's nutrient-management regulations require farmers to determine yield goals based on an average of their three highest-yielding years out of their latest five-year cropping sequence. If this information is not available, yield goals can be determined by some combination of similar data from neighboring fields, soil productivity calculations, and local yield averages (COMAR n.d.e). Farmers indicated in interviews and at public hearings that it will be difficult to justify what they believe to be appropriate and profitable nutrient-application rates for their farms, given the burden of proof required by nutrient-management regulations. For example, farmers note that varying weather conditions can cause significant yield differences from one year to the next. They argue that averaging their yield records to determine their yield goals underrepresents their yield potential and unjustly requires them to reduce fertilizer rates. Farmers believe this approach significantly affects their yield and earning potential. As one grain farmer put it, “I don't fertilize for my average yield, I'm going to fertilize for my best yield” (St. Mary’s County farmer, Charlotte Hall, Maryland, MDA nutrient-management regulations hearing, March 10, 2000). The following grain-farmer comments from Maryland nutrient-management hearings reflect those of LES grain farmers:

> My corn yield last year [1999] was 45 bushels an acre. With the same fertilization plan in 1998, it was 100 bushels an acre, but in 1997 it was 150 bushels an acre. I didn't change my plan any of those years. It’s the weather that has a lot to do with what we actually get for yields (Calvert County farmer, Annapolis, Maryland, MDA nutrient-management regulations hearing, February 22, 2000).
>
> A lot of us have had higher yields in the early 1990s than what we've had the last three years because of weather. And if we test three years out of five to determine our yield goal, we're ratcheting down our yields (Howard County farmer, Westminster, Maryland, MDA nutrient-management regulations hearing, March 9, 2000).
>
> Regulations could say best crop production year; base your production on that as opposed to an average. . . . I wish the state would consider that as a possibility; that we can obtain optimal

> yields, not just an average of ones that have been affected by weather (St. Mary's County farmer, Charlotte Hall, Maryland, MDA nutrient-management regulations hearing, March 10, 2000).

Many of the grain farmers I interviewed said that they need the decision-making flexibility to fertilize for the highest and most economically efficient yields their land can generate. They contend that they know their soil's productive capability and that given favorable weather conditions and the right amount of fertilizer they can achieve yields that are above average and reflect their productive potential.

> Some farmers have land with the capability of raising over 200 bushels an acre of corn. Other farmers have land that's capable of raising 100 or 140 bushels an acre. And I have farms myself that, depending on the soil type, the best I can hope for is 140 or 150 bushels an acre. That's all I expect. That's all I fertilize for. But I have other farms that I expect, and production history shows, to cut 200 bushels an acre on and I fertilize for 200 bushels. And as long as we get the rain, I'll get 200 bushels. But, the years I don't get the rain, I don't get it. And I know there are excess nutrients left in there (Rodney Rademann, January 23, 2001).

Similarly, if farmers do not have adequate yield records to document their yield goals, and county averages are used or yield data from nearby farms, they note that these determinations will be equally poor indicators of their yield potential. This, too, will adversely affect their yield and profit potential. As Stephen Borg and Nick Haus explained:

> The state is writing some of these nutrient-management plans based on county average yields. Well, with any average there's one below and one above. So this is really going to penalize

> people that are above-average farmers and getting above-average yields. Because they won't be able to put the nutrients down they need. . . . That is what we call sustainable agriculture. Now who is this sustaining? People don't talk about that. Because it's not sustaining me. I can't make a living like that. . . . I lose money (Borg, January 24, 2001).

> If you don't give a farmer the option to get a good crop, then he's not going to be able to stay in business. He has to go for the maximum crop. He can't go for the county average. In Somerset County, due to the bad 1980s with droughts and everything, we were down to an 85-bushel average. You'd better be doing 140 just to pay your bills. So, if your nutrient-management plan says that it takes X number of tons of chicken manure with this percent of nitrogen to go on your land, and they base it on 85 bushels an acre, they'll force you out of business. Economics will force you out. So you have to go for the maximum (Haus, January 26, 2001).

Farmers oppose averaged yield goals because they ultimately reduce yields by limiting nutrient-application levels, which threaten their ability to achieve the high yields that they believe are necessary to stay in business. Many grain farmers say they cannot survive on average yields.

> A farmer that produces an average crop for five years is out of business. In five years he's out of business if he doesn't produce above average yields and do a good job of marketing it (Tom Carter, January 5, 2001).

The following quote comprehensively illustrates grain-farmer understandings about their ability to achieve above-average yields, their need to pursue maximum yields, and the inflexibility of Maryland's mandated NMPs:

> I think nutrient-management regulations take away a farmer's opportunity to get a good year. You take last July, I was top

> dressing corn [application of fertilizer when corn is roughly 10 to 12 inches tall], and it was burned up, shriveled, barely worth gas for my tractor. I wasn't putting that much fertilizer on because of the dry weather; I'm not going to keep throwing good money after bad. But, if you get a good heavy wet spring, there's a lot of moisture in the ground, and the rest of the summer looks pretty good, I need the ability to throw that extra fertilizer into the corn to balance off my bad years that I've had before. . . . I have sandy soil that produces 60 bushels an acre of corn in dry weather if I'm lucky. Some years, with enough water, there's nothing wrong with sandy soil and it produces high-yielding corn as well as some other soils. But, if you look at my averages, they will not reflect my higher yields. And I need to be able to take advantage of that good year and I think that these nutrient-management plans will limit that (Calvert County farmer, Annapolis, Maryland, MDA nutrient-management regulations hearing, February 22, 2000).

Conduct On-Farm Evaluations.

> Farmers solve the majority of their problems with common sense. They actually physically experience a situation. Farmers' commonsense approach has been tested in the field. They did it themselves. They physically went in and applied that knowledge (Gary Knight, April 24, 2001).

Grain farmers are averse to adopting farm-management decisions and practices they have not first obtained through experiential knowledge. Evaluative practices are important to help manage risks and increase farm survival. An overarching philosophy of this evaluative approach is to carefully consider change over time before committing to it. Farmers' evaluative process involves education, on-farm experimentation and graduated levels of adoption over time based on performance, and cost-benefit analyses, which screen for potential production problems and reduce financial risks. Greg Schaffer and Tom Carter described the evaluative process this way:

> We tend to lay back a little more and kind of look out and see how things are going before we jump in and make a change (Schaffer, December 13, 2000).
>
> With the right education you will eventually prove to farmers that this is to their good. I'll take something new that comes out and I'll take 5, 10, or 20 acres and I'll try it. If it works, I'll try a little more. And if it works again, I'll try a little more. But, you can't come in here and say you're going to change your 1,000 acres today because I don't know if it will work and it's my nickel. I'm paying the bill and it's my livelihood at stake (Carter, August 5, 1998).

Herbert Brodie and Royden Powell (1995:456) have similarly described Maryland farmers' evaluative practices:

> Farmers cannot afford to make a big leap, so they make small steps. In nutrient-management planning they start with a small field just to see what will happen. They may repeat the test for a couple of years before deciding to expand to other crops or to a greater portion of the farm.

Farmers do not believe their farm-management knowledge and experience is irrefutable. Quite to the contrary, they told me that they welcome new production practices and technologies because they offer opportunities to expand their knowledge, improve their performance, and adapt to an ever-changing production environment. However, farmers argue that they must be allowed to evaluate proposed changes before they adopt them. One of several key reasons why farmers are so resistant to nutrient-management regulations is that they do not allow them to first evaluate the proposed production practices on their own farms before fully adopting them. As Tom Carter passionately exclaimed:

> Through regulation and mandated practices you're threatening the farmer and trying to force him into the unknown and you are not telling him any answers. And he wants to go slow. But you want him to jump in with both feet. And there may not be a bottom there. But you don't give a shit because you told him to jump. You're not jumping. You're going to stand on solid ground. You've told him to jump and you've forced him into jumping. You've forced him. And most people are not going to be forced because it is their livelihood. Those two people [his parents] that you saw come in here, they have farmed all of their lives. You are going to make them waste their retirement? Risk everything? They risk it anyway. But you are going to make the risk even more. You're going to make the risk insurmountable (August 5, 1998).

In contrast, farmers note that they widely supported Maryland's voluntary nutrient-management program because it embraced their evaluative process and allowed participation in it based on their assessment of its merits on their own farms over time. Farmers expressed their support for voluntary measures and opposition to regulatory ones in the following ways:

> If the state is not too forceful with farmers about nutrient management they will get a better response. If you tell a man he has to do it, he's going to rebel. And he's going to drag his feet as long as he can. . . . I will abide by a nutrient-management plan if it is not mandated (Danny Leery, August 21, 1998).

> You can lead a horse to water, but you can't make him drink. If you'll educate farmers to show them that things work they will use it and they will adopt it. If you try to force him to do it, he'll baulk. I know I will. You are not going to come in here and tell me what I'm going to do! To hell with you (Tom Carter, August 5, 1998)!

Many farmers proffered their belief that the voluntary nutrient-management program worked well because program sponsors had to persuade them that proposed practices and technologies made sense to adopt under actual production conditions. Since program sponsors cannot force farmers to participate in their voluntary efforts, they must create programs that will not only accomplish their goals but will also meet with farmer approval if they are to be successful.

> The voluntary program was good because it made what services either the University Extension provided or whatever, they had to be viable alternatives or the people didn't participate. So, if they were giving them good information and providing improvements all around, then people participated and it worked (Elmer Henkle, January 5, 2001).

Similarly, a senior representative from Maryland's Department of Agriculture--who was actively involved in facilitating both the voluntary and regulatory nutrient-management programs--also made the point that voluntary programs are valuable mechanisms for changing farmer behavior:

> About 80 percent of the [LES] farmers followed all or some of their voluntary nutrient-management plans. I thought that was a pretty good result. . . . In my mind, that showed that even if people were not fully sold on it, they were trying the plans and trying to educate themselves as to whether it worked or not. And that's typically how you change farmer behaviors. Farmers don't jump in with both feet. They test the water and then if it's OK they might get in. And that's how farmers were participating in our program.

More specifically, this MDA official made the case that farmers' ability to apply their evaluative practices to a policy program can help bring about lasting behavioral changes.

On the other hand, many farmers I interviewed made the argument that by forcing them to adopt mandated nutrient-management practices and denying them the opportunity to evaluate them over time and make their own adoption determinations, the state alienated them and created an incentive not to support regulatory program measures.

> Where I see the legislation failed is if water quality is the problem or issue, you've got to have a partnership working with the people to try to correct it. You can't come in like Big Brother and say you are going to do this or we are going to beat you for 15 minutes until you do, because there are so many ways around it; there are many loopholes that you'll find in anything. This situation will allow you to walk that tight line. And if water quality is the issue, you don't want the government to set a goal for people to walk on that line. You want through education and cooperation to strive beyond that line. But when you draw a line in the sand and say you must do this or else, and we achieve that goal or have the appearance to be achieving that goal, we can thumb our nose at them and say you know we did what you said. That's where I think the legislation failed (Mike Williams, August 20, 1998).

In addition, grain farmers suggest that cost considerations are a key component of their evaluative process. As Rodney Rademann explained:

> Farming is a business and the people that are in it have to make money. Consequently, they're spending a lot of money in investments for tractors and land and equipment, along with inputs like seed, chemicals, and fertilizers. And they need to get something back out of it to pay those bills and have a reasonable profit to live off of (January 23, 2001).

Grain farmers contend that they cannot make production decisions and adopt farm practices that are not cost-effective and expect to stay in business and make a living. Greg Schaffer and Patrick Casey explained it this way:

> With farm economics the way they are, you can't afford to go out on a limb and buy a whole lot of new equipment. Especially since you don't know what you're going to get on the other end in profits. I mean, a lot of things could happen like a dry summer (Schaffer, April 26, 2001).
>
> You have to still look at it from the business end. We're living off the land. We're making a living from what we produce on the land. And what we produce has to provide income for us and our families, and it has to pay for whatever equipment that we use to do it (Casey, January 23, 2001).

Finally, farmers resented what they perceived to be extensive recordkeeping and reporting requirements mandated by Maryland's nutrient-management regulations. In interviews and at nutrient-management regulation hearings, grain farmers expressed anger that the state did not adequately consider the labor and financial costs associated with recordkeeping requirements and nutrient-management plans. They were upset that the state was willing to mandate recordkeeping and reporting requirements without determining the economic costs of these activities over time (both in terms of farmer labor and professional services), and without attempts to sufficiently compensate them for their efforts.

> People are not following through on what responsible and intelligent people do. There's been no mention of the bottom line cost of the regulations. Nothing has been addressed as to the cost

of three to five years of recordkeeping. Has there been any determination of the costs of implementing over the long term this nutrient-management plan to the individual farmer? It's hard enough to make a profit as it is but all this recordkeeping is going to be a pretty costly process. I would suggest more study in general on the impact of the cost per acre over the long term, not just the set up of a plan or the early implementation, but the long-term recordkeeping costs to the individual farmer for various different operations (Wicomico County farmer, Salisbury, Maryland, MDA nutrient-management regulations hearing, March 2, 2000).

With nutrient-management plans and stuff we're supposed to supply yields per field and this, that, and the other. All right? You met the work force here when you came in the door [one young and two elderly family members]. You met the essential work force, tractor drivers, office personnel, and truck drivers. If you do all that maintenance and record keeping required by the nutrient-management regulations, that would take at least another person. We can't stand to have another $20,000 employee here. The business won't support it. And it's not as if I want that money for myself; I'm telling you, there isn't enough money. And regulation will require a lot of additional work (Tom Carter, January 5, 2001).

Chapter 7

Motivational Force of Farmers' Cultural Model for Grain-Farm Management

As discussed in Chapter 2, cognitive theory holds that cultural models and schemas become very durable, motivational, and salient in our lives when, through socialization processes, they are internalized with and linked to emotions and goals and provide us with understandings of ourselves, our relationship to the world, and the nature of our reality. As a result, we experience interpretations derived from these durable and motivational cultural models and schemas as both right and natural and part of the good self (D'Andrade 1995; Quinn 1992; Quinn and Holland 1987). D'Andrade (1992, 1995) and Quinn and Holland (1987) add that these cultural models and schemas, imbued with motivational force, provide us with our most general source of guidance, orientation, and direction. When activated, they function as high-level goal-schemas (or cultural models) that instigate action relatively autonomously. And as D'Andrade (1992) and Strauss (1992) note, high-level goal-schemas are embedded in many lower-level schemas and provide the motivational force necessary to realize the understandings and actions attributed to them. Finally, Quinn (1992) and Strauss and Quinn (1997) contend that early learning experiences are particularly influential in shaping the durability and motivational force of our most salient cultural models and schemas. One explanation for this effect is that early socialization is designed to effectively leverage our exceptionally strong feelings of survival, security, love, and acceptance, which we are particularly attentive to at this point in life, and associate them with specific understandings and behaviors that we learn to identify with as attributes of ourselves and our reality (Quinn 1992; Strauss and Quinn 1997).

This summary of the durable and motivational aspects of cultural models and schemas and the effect of early socialization experiences is particularly relevant in understanding the importance of farmers' cultural model for grain-farm management. Like other mid-level schemas, the goals prescribed to this model can, at times, instigate action, but they are not sufficient to make it a highly durable and motivational cultural model on its own. However, farmers' cultural model for grain-farm management is linked to a number of high-level goal-schemas that give it considerable durability and motivational force, making it a significant mechanism to realize and reinforce core understandings about who they are and the nature of the world they live in.

Space precludes a full discussion of some of the key higher-level cultural models embedded in and linked to farmers' grain-farm management model. A brief summary will serve here to illustrate how this grain-farm management model gains the motivational force necessary to accomplish farm-related tasks and goals that lead to the realization of higher-levels goals that reinforce farmers' core beliefs and values. In addition, this discussion will also help demonstrate how farmers' cultural model for grain-farm management serves as a cognitive framework for influencing and directing behavior, including whether to adopt mandated nutrient-management practices. The higher-level cultural models I present are “independence,” “farming as a way of life,” “environmental stewardship,” and “integrity and trust.” These cultural models not only help explain the reasoning behind and motivational influences of farmers’ grain-farm management model, but they are also relevant to policy discussions of how to develop nutrient-management programs that use farmers’ cultural-model knowledge to improve farming and reduce nutrient runoff. I discuss these policy and program implications in Chapter 8.

Farmers’ Cultural Model for Independence

The cultural model for independence is particularly important in shaping understandings and influencing and instigating action in farmers’ grain-farm management model. Farmers argue that one of the most defining characteristics of farming and farm life, and one that they most closely guard, is their independence or freedom. In fact, many farmers choose independence over making a lot of money. One significant reason they continue to farm is because it allows them to exercise a level of freedom not found in other professions.

Farmers claim that their independent nature is largely a result of the values and lessons their parents and grandparents instilled in them while growing up and working on the farm. These values and lessons were learned by participating in and observing farm work, as well as by direct instruction. Some farmers even indicated that they were raised with the belief that independence was to be revered and protected because it was one of the key principles that our nation was founded upon. Moreover, farmers have learned to associate considerable practical and cultural significance to being an independent farmer. Practically, farmers believe that making a living off the land in a rural environment requires them to have an independent and self-sufficient mindset to succeed; farmers ultimately have themselves to rely on for their survival.[1] And culturally, farmers' potential to maintain and exercise their independence is an indication of their ability to live their chosen way of life and become full members of their agricultural community.

In general, grain farmers exercise their independence through their production decisions--a core element of farm management. For example, because farmers are independent businessmen, they determine their production strategies, which they believe are vital to their success at making a living. Thus, grain farmers' ability to control and make their own production decisions is not only fundamental for them to make a living, but also to maintain their independence and preserve their way of life. Furthermore, farmers' close identification with attributes of independence makes it an important goal and carries with it considerable motivational force to ensure its pursuit. Their cultural model for grain-farm management, with all its decision-making demands, is a primary vehicle for farmers to realize independence and validate their understanding of who they are and what they value.

Farmers' Cultural Model for "Farming as a Way of Life"

As a way of illustrating how important farming is to their lives, farmers note that their profession is much more than a business and a means to make a living; it is a way of life. Their entire lives revolve around working on their farms. According to farmers, grain production requires a willingness to work more than eight hours a day, seven days a week, for at least eight to nine months of the year to accomplish necessary and time-sensitive tasks. And during the off season (December through February), grain farmers must service their equipment, prepare farm-management and -program reports (some required by state and federal agencies), assess their financial standing, and create next year's marketing and production plans. Thus, farmers argue that you have to love farming to do it because you have to spend a considerable amount of time most of the year working at it.[2]

Moreover, farmers suggest that their way of life is premised on the understanding that they farm because they love doing it and enjoy the lifestyle that accompanies it, and not because they are motivated by making money. In fact, farmers commented in interviews that farming is much more than a means to make money; it is what they love to do most. They argue that they work too many hours and take too many financial risks for small returns to be motivated to farm by any other reason than their love for it.

In addition, farmers note that their way of life is focused on family. Many are the third or fourth generation (or more) to farm and live on (or near) the same land. They were raised with the understanding that farming and family life are integrated and that family is essential to farm success. For example, because grain farming is labor- and resource-intensive, the combined efforts of immediate and extended family helps to ensure the completion of necessary farm-related tasks. Given the challenges posed by nature and the market, family is a source of aid and refuge in troubled times. Furthermore, each generation of family members makes it possible for the next to farm. For instance, farms are the cumulative efforts of generations of family members who have invested their lives and resources to make them viable. Farmers not only inherit the holdings that are the result of these intergenerational efforts, but also the agricultural knowledge, experience, and way of life of their predecessors that are fundamental to farm success and the preservation of family.

Farmers frequently commented that one of the major reasons they enjoy farming is because it allows them to work from home and spend more time with family. It is important for them and their spouses to be able to raise their children themselves and develop close relationships in a family-farm environment. By living and working on the farm with their children, they have the opportunity to eat the majority of their meals together and work and play side-by-side. Farmers indicated that this allowed them to closely witness their children's growth, as well as develop strong personal relationships with them that can only be achieved through extended interaction.

Perhaps the most dynamic, meaningful, and emotive element of farmers' way of life is the farm. In brief, the farm encompasses, and is representational of, all aspects of farmers' lives--past, present, and future. Farmers even consider their farms to be extensions of themselves and expressions of their identity. In addition, the farm is also a link to farmers' agricultural heritage, and is the embodiment of the lives of past generations of family members who also lived and worked there. Finally, the farm is a means to live a preferred way of life and preserve ancestral ties to the land. Thus, strong personal, familial, and cultural links to their farms give considerable import to their lives.

Farmers also said they have a strong attachment to their farms because they are the source of memorable childhood experiences of interacting with extended family members and living, working, and playing on the farm. Many noted that they grew up on the farm where they currently live and work. They told of being raised on the farm and the memorable occasions they had with family members. From accompanying grandparents on their tractors as young children to working alongside family members doing farm chores to swimming in the farm creek with family after bailing hay to cutting holly with family at Christmas time to family get-togethers accompanied by great food to experiencing the birth of calves to fishing and hunting with their fathers to gaining increasing amounts of responsibility in the production process, the farm was a major force in farmers' development to adulthood.

Farmers' sense of self is intrinsically linked to numerous aspects of farming and farm life, imbuing many of the farm-related cultural models and schemas that organize, interrelate, and connect them with considerable motivational force--including their cultural model for grain-farm management. Thus, beliefs and practices that comprise the cultural model for grain-farm management are viewed as normal or typical elements of their way of life that they closely associate with their identity and have a strong motivation to pursue. In addition, as with their cultural model for independence, farmers' cultural model for grain-farm management is a primary mechanism to realize a way of life, which heightens the import of their management beliefs and practices. As a result, farmers' desire to make enough profit to run a successful business and make a living is intensified because failure to do so would mean more than losing their job; it would mean the loss of an entire way of life that defines them.

Farmers' Cultural Model for Environmental Stewardship

Farmers believe they also have a responsibility to maintain the environmental quality of their land. As caretakers of their land, farmers refer to themselves as "environmental stewards." Safeguarding the health of their land has both moral and practical underpinnings. Most farmers believe that God gave man dominion over the environment to use as a resource to feed, clothe, and shelter him. They do not believe, however, that they have an unlimited authority to do with the land as they please. Instead, they feel obligated to use the environment in a responsible manner.

Along with their moral obligation to protect and conserve the environment, farmers have economic motivations to maintain its health. Grain farmers make their living off the land, and if it is not healthy and productive their livelihood is at risk. Thus, farmers believe that it is paramount for their survival to maintain the health of their natural resources. They argue that it does not make sense for them to hurt their land because they would be hurting themselves. Also, farmers suggest that if they had not been environmentally conscious historically they would not have been able to continue to make a living off the land and provide the commodities needed to sustain our country. As a result, they believe that they are the real environmentalists and refer to a popular slogan and bumper sticker: “Farmers are the first environmentalists.”

Moreover, farmers argue that protecting and conserving their natural resources is the right thing to do for the environment and is fundamental to their short- and long-term survival. They say they have the right to use the environment as a productive resource, and they have an obligation to maintain its health and productive value.

Farmer understandings of environmental stewardship are significant because they have a direct bearing over their farm-management strategies and goals. For example, farmers feel a strong sense of obligation to make farm-management decisions that strike a balance between what is needed to make a living and run a profitable business and what is needed to protect the environment. As a result, they believe it is their right to use their natural resources to make a living, which inevitably will result in some adverse environmental effects beyond their control. However, farmers feel obligated to mitigate these effects to the extent possible by using best-available practices and technologies--whose use still allows them to make a living--to address them.

Farmers' Cultural Model for Integrity and Trust

Integrity and trust are fundamental elements of farming and farm life. Farmers draw on a strong sense of right and wrong to guide their actions. These understandings are grounded in generally shared moral values influenced by Christianity. And even though some farmers I spoke with are not ardent church goers, all said that they came from families with strong Christian backgrounds and that Christian beliefs have had a profound effect on their lives.

These moral values are more than lofty, ideal behaviors; they are incorporated into their everyday lives: "You live your values on the Eastern Shore" (Danny Leery, August 21, 1998). One of their most influential moral values is the Golden Rule. You do unto others as you would have them do unto you because it is the right thing to do, not because you expect to gain anything from your actions.

Farmers also feel a strong moral obligation to safeguard the natural resources under their care. It is immoral to profit from the purposeful abuse of the environment. The very nature of farming results in some environmental effect, but the activities that produce that effect are not premised on destroying the environment to make money. Farmers argue that they need to make money to stay in business and continue their way of life, but they cannot justify making profit at the expense of the environment.

They believe their way of life is an inherently moral way of living and deserves a certain level of societal respect. For example, farmers suggest that they have traded profits to live a way of life that they enjoy. One which emphasizes hard work, modest living, family, community, a love for nature, and Christian principles, and produces the food our nation needs to thrive. Thus, they believe that the combination of their motivations to farm, the nature of the work itself, the values that they espouse, and their contribution to society, makes farming an honorable profession.

According to farmers, having integrity and demonstrating it through your interactions with others builds trust. Trust is an important aspect of farming because it is essential to building and maintaining productive relationships. Strong relationships are vital to farmers' ability to make a living. Trust is earned and is a product of the nature and quality of one's relationships over time. In the beginning of new relationships, they are willing to extend a certain level of trust. Farmers gauge the behavior and motives of new acquaintances over time and extend more trust if it is earned. However, if farmers believe that an individual's words and deeds show a lack of integrity, trust and respect can be lost. Once trust is lost, it is hard to get it back.

My sense is that farmer trust is extended to those who exhibit what they consider to be culturally appropriate behavior. This behavior does not violate farmers' core values, undermine their farm-management approach, and threaten their way of life. In addition, it demonstrates respect for farmers' agronomic knowledge and way of life, and exhibits an interest in farmers' wellbeing and an understanding of what it takes to make a living farming. In other words, farmers extend trust to those who behave in ways that reflect farmers' sense of what is right and natural.

The relationship between farmers' cultural models for integrity and trust and management is expressed in their evaluation of their farm-management decisions and practices. Farmers draw on their cultural model for integrity and trust to assess the appropriateness of their management decisions and practices, as well as the behaviors of those they interact with in the process of making those decisions and implementing related practices. Moreover, because farmers' sense of self is closely associated with their cultural model for integrity and trust, the decisions, practices, and behavior evaluations that result from the application of this model have considerable motivational force.

Farmers' management strategies and goals are grounded in their sense of integrity and trust, and they perceive their pursuit as right and natural. Conversely, efforts by others to alter these strategies and goals may be viewed as amoral and unnatural, motivating farmers to resist them. This is particularly applicable where farmers' decision-making authority and flexibility are challenged, threatening not only their ability to make a living, but their means to realize core beliefs and values that define themselves and their reality. Finally, farmers' negative evaluations of others' behaviors in response to management beliefs and practices can have considerable cumulative effects because of their motivational force. For instance, farmers' negative evaluation of a behavior related to the critique of a farm-management belief or practice may become the dominant understanding associated with the critiquing agent and his effort. As a result, farmers may similarly frame interpretations of subsequent experiences with like agents and efforts (even though they may be different), preventing alternative knowledge from being considered.

Chapter 8

Policy Implications of a Cultural-Models Approach

One of the benefits of a cultural-models approach is its ability to illustrate the cognitive process through which meaning is constructed and behavior is influenced and instigated. This knowledge can be particularly useful in policy efforts that seek to bring about behavioral change in target populations because it helps to explain how the cognitive process can inhibit or facilitate change. This knowledge, married with an understanding of a target group's interpretive cognitive framework (i.e., its cultural models and schemas), including higher-level goal-schemas, can provide information to increase the effectiveness of policy initiatives by ensuring that they adequately reflect group members' cultural models and schemas. In the following paragraphs I will explore the policy implications of some of the cognitive processes I discussed in Chapter 2. In particular, I will focus on those ideas and cognitive processes that are relevant to policy efforts to bring about behavioral changes in target groups.

Appeals to Preexisting and Compelling Cultural Models Promote Behavioral Change

In one example of how the cognitive process can affect policy-related behavioral change, Quinn (1992) and Quinn and Holland (1987) make the case that cultural models and schemas play a pivotal role in the state's ability to persuade its citizenry to adopt policies that it believes are necessary. They suggest that cultural models and schemas are the source of ideological force needed to motivate individuals to take desired actions. They explain that the state depends upon the public's willingness to consent to its plans to effectively govern. To accomplish this, the state must "promulgate ideology persuading people to do what they otherwise might question or resist doing" (Quinn and Holland 1987:13). Ideological persuasion is necessary because power and resources alone are not always sufficient mechanisms to accomplish the task. For ideology to be a persuasive tool it must "appeal to and activate [the public's] preexisting cultural understandings, which are themselves compelling" (ibid.). Therefore, for ideology to be convincing, it must be perceived as natural or right, which is a feeling-state associated with cultural models and schemas imbued with motivational force. In Quinn's (1992:122) words: "To be persuasive, ideological appeals must draw upon shared assumptions either about the rightness and legitimacy, or about the naturalness and inevitability, of the social order."

Furthermore, quoting Lewontin, Rose, and Kamin (1984), Quinn and Holland (1987:13) explain that the reason why ideology posed as legitimate or inevitable is convincing is because "if what exists is right, then one ought not to oppose it; if it exists inevitably, one can never oppose it successfully." In addition, just as cultural models and schemas that are internalized as self-understandings have considerable motivational force and function as our most general goals, ideology is most convincing if it reflects one's shared sense of self and place in life:

> A given ideology is most compelling if its rightness engages the sense one has of one's own personal uprightness and worthiness, or if its inevitability engages the view one has of one's own needs and capacities. These matters lie at the heart of our understanding of ourselves and our place in life. They are also largely cultural matters (Quinn and Holland 1987:13).

Moreover, Quinn (1992) adds that our self-understandings about what are right and natural are a powerful ideological hook because people are willing to embrace ideological appeals to them even though they may be otherwise disadvantaged in the process. Conversely, when ideological appeals conflict with self-understandings, they can result in an equally powerful charge to resist them. Thus, despite some potential for abuse, successful ideological appeals to compelling cultural models and schemas have a great capacity to create culturally relevant policy that serves the interests of both policy makers and the populations that their policies target.

Preexisting Cultural Models Can Prevent the Consideration of Alternative Understandings

Policy efforts designed to bring about behavioral change in target groups, in part through educational vehicles, should seriously consider the merits of appealing to their compelling, preexisting cultural models and schemas. The introduction of new ideas and behaviors to a group that are not reflective of its interpretive framework is often overridden and never fully considered. As Strauss and Quinn (1997) explain, new knowledge is always incorporated, rejected, and remade in relation to and interaction with previous cultural models and schemas. When these cultural models and schemas become relatively stable over time, they are more likely to frame interpretations of subsequent experiences that activate them than to be influenced by alternative understandings (ibid.). Thus, when new experiences or understandings are introduced that are "under-schematized" (i.e., do not fully relate to existing cultural models and schemas), they are likely to activate durable preexisting cultural models and schemas with similar experiential features that result in interpretations that confirm original understandings and prevent new ones from surfacing (ibid.). This understanding of the cognitive process suggests then that new knowledge may not become an avenue for change if it does not relate to existing cultural models or schemas.

Therefore, Strauss and Quinn (1997:40) contend that operating within a group's interpretive framework holds "the greatest potential for fundamental cognitive and behavioral change." For example, they argue that one of the most promising approaches is to draw on and link existing cultural schemas that were previously isolated (at least consciously) from one another to create new conscious understandings that gain in salience because of their new association with established schemas. As Strauss and Quinn (1997:40-41) explain:

> Pointing out connections between previously isolated bits of people’s assumptions [or a number of cultural models and schemas that may be only loosely connected] can create both greater awareness of those bits and new cognitive links among them, the result of which will be a much more frequently accessed schema that becomes increasingly salient.

In other words, by creating links among previously disconnected memories and assumptions, when one part is experienced the whole set is likely to come to awareness, strengthening the relationship between them and the salience of the new understanding (ibid.).

The Motivational Force of Cultural Models Associated with Proposed Policies and Programs Can Significantly Influence Behavioral Change

Knowledge of cultural models’ and schemas’ motivational function is another part of the cognitive process that has much to offer efforts to bring about behavioral change. It is another facet of the need to relate new understandings to existing cultural models and schemas. As previously discussed, some cultural models and schemas serve as goals that instigate action relatively autonomously, as well as provide the directional force for other lower-level cultural models and schemas to which they are linked. D’Andrade (1995), Quinn (1992), and Strauss and Quinn (1997) note that the cultural models and schemas that have the greatest potential for motivational force are those that provide us with understandings of ourselves and our relationship to the world, as well as the basic assumptions that underlie the nature of our reality. Further, D'Andrade (1995), Holland (1992), and Quinn (1992) argue that identification with cultural models and schemas is particularly important in their development of motivational force. Holland (1992) adds to this that involvement and identification with certain cultural models and schemas can simultaneously develop in relation to one another as individuals gain a sense of expertise in them, which in turn increases their motivational force.

Thus, the activation of goal-schemas can play a valuable role in creating motivational force that either facilitates or inhibits behavioral changes. For example, policy efforts that threaten the obtainment of existing goal-schemas--and the continuance of mechanisms through which they are achieved--may generate considerable motivational force to resist proposed activities. To the contrary, policy efforts that promote and reinforce existing goal-schemas, and the cultural models and schemas through which they are reproduced, may motivate action that leads to change.

Knowledge Acquisition Can be Culturally Determined and Context-Specific

Finally, the recognition within cognitive studies (D'Andrade 1995; Strauss and Quinn 1997) that we live in a socially constructed environment and that objects and practices within this extrapersonal world can structure what and how we learn has significance for how the cognitive process can affect behavioral change. For example, if behavioral change relies on education and the introduction and incorporation of new knowledge, and a target group has learned to associate a particular knowledge type and learning style with a practice in question that runs counter to those promoted in change efforts, then it is likely that the message of change will be poorly received. Strauss and Quinn's (1997) discussion of Bourdieu's concept of "habitus" is helpful in illustrating how aspects of the extrapersonal world can structure the learning process and influence receptivity to change. Bourdieu's "habitus" is similar to Strauss and Quinn's (1997) concept of "intrapersonal" culture, and can generally be thought of as the mental structures that result from the internalization of cultural experiences, particularly those related to everyday practices.

Drawing on Bourdieu's discussion of "habitus," Strauss and Quinn (1997) note that knowledge learned from experiences that are the result of everyday practices (i.e., elements of the extrapersonal world) are not internalized as "hard-and-fast rules." This knowledge is more general than rules because everyday practices are variable from one day to the next. Nevertheless, general knowledge learned from everyday practices still remains within culturally accepted boundaries. The point to emphasize here is that the variable nature of everyday practices structure how we learn, which is not through hard-and-fast rules. In addition, knowledge acquired from everyday practices is not precise because that would fail to capture the inherent variability of the daily experiences from which it is derived. Thus, this knowledge "consists of more general categorical relations that can be realized in different ways, depending on the context" (Strauss and

Quinn 1997:44). This allows individuals to flexibly react to new contexts instead of repeating the same practices.

Individuals may closely associate certain ways of learning and types of knowledge with particular extrapersonal contexts, and alternative learning approaches and knowledge types presented in the same context may be rejected because of their perceived incompatibility. Strauss and Quinn's (1997) discussion of Bourdieu's work has significant utility for understanding the important role that culturally contextualized educational campaigns can have in affecting behavioral change.

Chapter 9

Nutrient-Management Policy Implications of Farmers' Cultural Model for Grain-Farm Management

Farmers' cultural model for grain-farm management has a number of general and specific nutrient-management policy implications. In addition, these same implications are also relevant for many other policy and program efforts focused on agricultural practices. Given farmers' understanding of the importance of the beliefs and practices that make up their farm-management model, and the significant function that this model serves in facilitating farmer realization and maintenance of their identity, the overall model and many of its specific propositions have direct policy relevance. In terms of the farm-management model itself, and considering the cognitive theory that suggests that new ideas and behaviors are best understood and considered in the context of compelling, preexisting cultural models and schemas, nutrient-management policy efforts that reflect farmers' management beliefs and practices are likely to receive their support. More specifically, the following policy propositions that complement key farm-management model beliefs and practices are more likely to be received favorably by farmers than those that conflict with them:

1) Policies that recognize and make allowances for the imperfect nature of grain farming;

2) Policies that demonstrate flexibility and are not solely governed by hard-and-fast rules;

3) Policies that recognize and promote farmers' decision-making authority and are not governed, but facilitated, by scientific knowledge;

4) Policies that allow farmers to evaluate proposed practices on their own farms over time before adopting them;

5) Policies that recognize farmers' need to make a living and run a profitable business and demonstrate that proposed practices will not jeopardize their livelihoods;

6) Policies that recognize and promote the value of farmers' management and agronomic knowledge and experience;

7) Policies that demonstrate integrity, cultivate trust, and show respect for farmers' way of life; and

8) Policies that recognize and promote farmers' environmental stewardship.

Policy Relevance of "Conducting On-Farm Evaluations"

Several of the above policy-related links to components of farmers' cultural model for grain-farm management show particular promise as vehicles through which nutrient-management policy efforts might be most successful. One such farm-management component is farmers' management strategy of "conducting on-farm evaluations." Holland (1992) argues that the motivational force of cultural models and schemas can develop as one acquires a sense of expertise in some aspect of them. In turn, expertise is achieved as the result of involvement and identification with certain cultural models and schemas that develop simultaneously in relation to each other as one acquires greater knowledge of them. This notion supports farmers' on-farm evaluative process for change, which requires time for them to become familiar with proposed practices, to identify with them as elements of their cultural system, and to develop the expertise and confidence in them to fully integrate them into their farm-management system. Moreover, this suggests that nutrient-management policy that recognizes lasting behavioral change as a process that encourages small to increasing levels of policy-related program participation over time, building familiarity and identification with program practices that leads to expert knowledge of them, will have a greater chance of being fully adopted and perceived as natural and right than alternative policy efforts that bypass farmers' evaluative approach. In addition, this nutrient-management policy approach is congruent with farmers' cultural models for independence and integrity and trust, which may facilitate farmer support for and participation in like policy efforts.

Policy Relevance of "Maintaining and Executing Decision-Making Authority and Flexibility"

Another element of farmers' cultural model for grain-farm management that could be an important avenue for policy makers to explore in creating effective nutrient-management policy efforts is farmers' management strategy of "maintaining and executing decision-making authority and flexibility." The emphasis here is in presenting farmers with a nutrient-management policy package that has clearly defined and measurable goals and preserves their decision-making authority and flexibility in meeting those goals and their own production needs. For example, nutrient-management policy-related programs that provide farmers with a wide array of nutrient-management practices and decision-making tools that they have the authority to choose from and combine to meet policy goals, and a range of flexibility within those practices and tools that would allow farmers to adjust them according to their unique farming circumstances, are likely to garner their support and participation. In addition, farmers would also favorably receive policy programs that offer timely technical assistance that they can routinely draw on to help facilitate key nutrient-management decisions. They would also welcome monetary assistance to defray the excessive costs of proposed nutrient-management practices and to ensure against production failures that may result from their adoption.

Farmers are particularly sensitive to the need for flexibility in determining nutrient-application rates. They believe that nutrient-application rate determinations should accommodate their beliefs that scientific knowledge and decision-making tools are imperfect, that their knowledge and experience provides context-specific production knowledge that needs to be applied to make a living, and that production environment challenges need to be fully integrated into nutrient-management decisions. Thus, farmers are more likely to support rate-determination efforts that allow for these accommodations than those that do not. For instance, farmers' concerns related to decision-making authority and flexibility may be addressed by working with them to establish an acceptable range of nutrient-application determination rates around some base rate. This approach may be particularly productive because it is associated with and favorably supported by other farmer cultural models and schemas: integrity and trust; nothing is perfect; tradeoffs and allowances are necessary.

The Need for Culturally Appropriate Knowledge to Evaluate the Merit of Policy Proposals

Farmers have science-based information needs associated with nutrient-management policies, programs, and practices that are not being met in ways that allow them to fully assess their merits and applicability to their operations. In essence, farmers are being asked to adopt knowledge and practices that are incompatible with the types of knowledge and practices they recognize as legitimate. Policy makers and scientists who situate their science-based farmer nutrient-management communications and offerings in the context of what farmers perceive to be culturally accepted knowledge types and learning processes are likely to be better received and more fully considered than those presented through alternative approaches. One senior-level Maryland Department of Agriculture representative echoed this sentiment: “You can't just hand out the science and expect that it will be openly accepted as evidence. Mold it within their culture, if you will.”

Strauss and Quinn’s (1997) discussion of Bourdieu’s “habitus” has significant utility for understanding the powerful, interrelated relationship between farmers’ extrapersonal farm environment and their farm-related knowledge and learning preferences, and the potential that these understandings hold for acceptance of or resistance to state efforts that attempt to get farmers to adopt alternative nutrient-management beliefs and practices. Bourdieu’s analogy of how the variable nature of everyday practices structures the learning environment dovetails with my findings of farmers’ experience. The results of this extrapersonal structure, as described by Bourdieu in Strauss and Quinn (1997), are also the same for farmers, producing for them a learning style and knowledge base that is adaptive and able to accommodate the ever-changing variables that comprise their production environment. In stark contrast to their learning and knowledge preferences, farmers indicated that Maryland’s nutrient-management approach emphasized the value of what can be generalized from scientific studies, hard-and-fast rules, and precision. Farmers saw this approach as inherently alien to their experiences and could not support nutrient-management policy that was premised on such seemingly unnatural understandings. Despite this example’s negative connotations, it also holds great promise because it illustrates what type of knowledge and learning process farmers are likely to support.

The Need to Validate the Merit of Policy Proposals through Real-World Demonstrations

More specifically, farmers argue that if the state wants them to "buy into" and adopt their science-based nutrient-management findings and practices, the state needs to further validate the merit of their efforts through an on-farm evaluative process. In particular, farmers contend that the state needs to demonstrate the real-world applicability of their findings, including how they support farmers' ability to run a profitable business, make a living, and meet societal food demands. For example, many farmers noted that they would be more accepting of state-supported nutrient-management and -runoff science and practices if the state were to demonstrate its beliefs and findings through field trials--under actual production constraints--with a sample of well-respected farmers throughout Maryland. They indicated that if these studies with farmers, who are generally recognized among their peers as superior farm managers, showed the merits of and problems with specific nutrient-management beliefs and practices they would be more convincing. An important component of these demonstration studies would be to show how farmers can still run viable operations by incorporating eco-friendly practices.

Field trial areas of interest for farmers include exploring field-specific levels of nutrient runoff, comparing the success of scientifically derived nutrient-application rate determinations versus those based on farmer judgments in terms of ability to make a living, and the effectiveness of buffer zones, cover crops, and other related BMPs to reduce nutrient runoff. In most instances, farmers are not looking for definitive findings, which they believe are largely impossible when working with nature, but some general quantifiable evidence--like nutrient runoff levels in ditches and small streams adjacent to fields--that can be used to support larger scientific findings. Farmers explained that they are reluctant to change farm-management practices that allow them to make a living and reflect significant eco-friendly improvements over the last several decades when policy makers and scientists suggest that bay water quality has shown little (if any) improvement as a result. Thus, they are not eager to undertake costly and time-consuming practices when they have no real sense of their effectiveness. Demonstration projects could provide some of the reassurance that farmers need that the time and money they spend on nutrient-reduction efforts are making a legitimate difference.

The Importance of Farmer Policy-Proposal Queries and State Policy-Proposal Presentations to Farmer Evaluation of Policy Merit

Policy makers and scientists should not only demonstrate the validity of scientific findings and practices through field studies, they should also address farmer queries about proposed policies and programs in the context of their larger farm-management framework. Part of their on-farm evaluative approach is to gather information from a number of firsthand and secondhand sources over a period of time to determine whether they should actually try a proposed practice. If farmers cannot make a case for why they should at least try a proposed practice, they are likely to abstain from it. Thus, farmer queries to policy makers and scientists about the merits of scientific understandings and proposed practices that go unaddressed or receive responses that do not make sense within their evaluative framework, signal to farmers that they may not be worthy of their support. In this instance, farmers' preexisting cultural models and schemas are likely to prevent the further consideration of new knowledge. If responses challenge farmer understandings of themselves and their way of life, threaten their ability to make a living, and do not conform to beliefs about appropriate interpersonal interactions, farmers' cultural model for integrity and trust is likely to be activated and provide the motivational force to not fully consider proposed practices. As farmer support for Maryland's voluntary nutrient-management program and opposition to nutrient-management regulations suggests, once farmers feel threatened or violated by proposed practices and related activities, they may reject them even though under other circumstances they might embrace many of the same practices.

The wide range of knowledge and skills that farmers develop out of necessity also makes them astute critics of policies and programs targeted at them. For instance, farmers' system of logic, grounded in their rich experiences, is a valuable tool in identifying the shortcomings of scientific findings and related proposed practices. In particular, they frequently assess the adequacy of these findings and practices by whether the logic used to promote them is sound. As a result, policy makers and scientists need to make sophisticated, well-substantiated scientific arguments grounded in actual production conditions if they want to garner farmer respect and support for their proposals. In addition, farmers are particularly attuned to the limitations and evolving nature of scientific findings, so arguments made that proposed practices are necessary and are well supported by scientific evidence will have a high burden of scientific and practical proof in farmers' eyes. This is particularly true as the potential negative effects from adopting proposed practices increase.

Policy Relevance of Farmers' Understanding of Nutrient Management in a Farm-Management Context

Farmers may not support measures to change some of their nutrient-management practices to reduce nutrient runoff because these practices may be perceived as necessary for their survival and runoff may be considered an act of God. According to farmers, nutrient use is determined by farmers' evaluation of their nutrient needs based on their own knowledge and experience, as well as assessment of data from scientific studies, tests, and decision-making tools. Given the financial and knowledge uncertainties and limitations characteristic of grain production, farmers must fertilize each year for the highest, most cost-effective yields they believe their fields are capable of producing. They contend that this is part of a long-term farm-survival strategy that ensures that they take advantage of good growing seasons to compensate for poor ones. Thus, any nutrient use beyond state-recommended levels is a function of what farmers believe is necessary for their survival and not the outcome of anti-environmental beliefs and practices.

Once nutrients are applied according to “reasonable” best-management practices, farmers believe that nutrient runoff is a function of Mother Nature or God, and is an unavoidable byproduct of grain farming. Therefore, farmers perceive nutrient-management regulations as an unjust punishment. Regulations penalize them for using nutrient levels they believe are necessary to make a modest living and meet societal food needs, and they hold them accountable for nutrient runoff that they cannot prevent despite their best efforts. Since farmers believe that nutrient-management regulations are unjust, their opposition to them takes on a heightened significance because they unnecessarily threaten the loss of their identity and way of life. At this point, regulations become immoral and compel farmers not only to oppose them, but, with just cause, to violate them when necessary. As a result, future nutrient-management efforts that do not address farmer beliefs that certain practices are essential to their survival and that some nutrient runoff is unavoidable will continue to receive negative feedback and opposition from farmers.

Chapter 10

Conclusion

Federal and state agencies have identified agricultural nutrient runoff as a significant threat to the health of our nation's waterways. In addressing this problem, one is immediately confronted with its tremendous scope--the U.S. has more than 900 million acres of farmland on over 2 million farms (NASS 2004b). In the Chesapeake Bay watershed alone, there are more than 87,000 farm operations and 6.5 million acres of cropland (CBP 2007). And the scale of the bay agricultural nutrient-runoff problem pales in comparison to that found in the Northern Gulf of Mexico (NGOM), where 31 states within the 1.2 million square mile Mississippi-Atchafalaya River Basin (MARB) contribute farm runoff that is largely thought to be responsible for the gulf's hypoxic condition (MRGOMWNTF 2008).

The scale of the agricultural nutrient-runoff problem suggests that some approaches to address it will inevitably be cost-prohibitive in the long-run. For example, Doering et al. (1999) argue that regulatory approaches can have extensive administrative and enforcement costs if they are designed to ensure that farmers comply with mandated nutrient-management practices that they most likely do not support. Even with greater expenditures on enforcement, Jones, Boushey, and Workman (2006) note that increased levels of monitoring to ensure compliance can produce effects opposite those sought, creating such high levels of resentment among target groups that they no longer respond to positive or negative incentives. It is also unlikely that federal agencies and state governments will ever have the financial means to fund billions of dollars worth of yearly conservation and nutrient-reduction programs needed to adequately mitigate agricultural nutrient-runoff threats. For example, in 2004, EPA's Chesapeake Bay Program, in cooperation with bay states and the District of Columbia, estimated that bay cleanup costs could be more than $30 billion over the course of the next five or six years (Blankenship 2004).

Therefore, I argue that federal agencies and state governments need to pursue cooperative and collaborative nutrient-management policy efforts with farmers that garner their respect, interest, and long-term support. More specifically, I contend that the success of these collaborative policy efforts can be significantly enhanced by greater knowledge of the cultural models and schemas that shape farmers' management beliefs and practices and inform their understandings of themselves and their relationship to the world. By situating policy efforts and proposals within the context of farmers' compelling cultural models and schemas, policy makers are more likely to create nutrient-management policy that farmers are willing to adopt. Because of farmer policy support and adoption, environmental goals are more likely to be achieved. A key element of this strategy is to successfully link policy ideas and practices with farmers' higher-level cultural models and schemas and leverage the motivational force associated with them to earn their support. I am not proposing a potentially unethical manipulation of farmers' cultural models and schemas to achieve policy goals. To the contrary, I am suggesting that by successfully situating policy efforts within farmers' shared cognitive framework, they will ultimately be relevant to farmer interests and concerns and will garner their support.

Finally, the scope of the agricultural nutrient-runoff problem in areas like the Chesapeake Bay and the Northern Gulf of Mexico extends beyond calculations of farm numbers and acres and watershed size. The scope can also be determined by the magnitude of the societal issues that it raises. These issues bring to the forefront significant societal questions about how we should produce our food and what price we are willing to pay to implement more eco-friendly production practices. Our existing macrolevel policies and understandings (both implicit and explicit) have largely shaped farmers' agricultural production decisions and practices, which have resulted in abundant and relatively stable and cheap food supplies in the U.S., as well as adverse environmental and human-health effects.

I contend that successful efforts to mitigate agricultural nutrient-runoff concerns must not only focus on problems at the farm level, they also must address the macrolevel forces that continue to structure farmers' agricultural production decisions and practices. If farm-level efforts are not accompanied by significant societal reforms, it is likely that the preponderance of farm-level measures will increase the cost of production to the extent that they further diminish the number of farms and farm operators. One result of this downsizing is the loss of generations' worth of valuable farming knowledge and experience that could be used to enhance more sustainable food-production efforts. Another result is the concentration of commodity production and land ownership under the control of increasingly fewer individuals. Goldschmidt (1978) and others (Albrecht 1997; Barlett 1989; Davidson 1990; Fitchen 1991; Lasley et al. 1995) have shown that this type of concentration can have deleterious societal effects.

There is considerable evidence that our conventional agricultural production system needs improvement. It is energy and capital intensive, threatens environmental and human health in a variety of contexts, and inadequately meets the financial needs of many farmers. Farm-level changes like those offered by Maryland's nutrient-management regulations are part of laudable national efforts to transform agricultural production by reducing its effect on water quality. One must ask, however, whether the cumulative effects of nutrient-management policies and programs designed to improve water quality support the achievement of multiple, interrelated societal goals. For example, do Maryland's nutrient-management regulations also support measures to produce a secure (abundant, safe, and accessible), high quality (nutritious), and affordable food supply? Do they promote a form of production that keeps farmers on the land, allows them to make a livable income, and improves their quality of life, all of which may be necessary to meet our food-related goals? The point is not that environmental quality should be sacrificed to save farmers and meet our food needs. This would not be a desirable or sustainable solution. Rather, the point is that policies and programs designed to transform elements of our conventional agricultural production system must include both macro- and microlevel measures that comprehensively consider and integrate the needs and goals of our entire food enterprise (production, manufacturing, distribution, retail, consumption). This approach increases the likelihood that farmers would support efforts to reduce nutrient runoff because farm profitability and environmental-quality goals would be better integrated and more complimentary.

Furthermore, I argue that the water-quality challenges posed by agricultural nutrient runoff present a unique opportunity to simultaneously reform our nation's agricultural production system and secure and enhance the future of existing farm operators. Policy makers and farmers must recognize that only by working cooperatively and collaboratively can they achieve both long-term environmental and farm-management goals. A better understanding of the core cultural knowledge and cognitive frameworks that shape and motivate farmer decisions and behaviors, as well as those of policy makers and scientists, can be one of the primary mechanisms to facilitate these collaborative efforts.

Notes

Chapter 1

[1]By focusing on grain farmers I do not mean to discount the significance of poultry growers' contribution to agricultural nutrient runoff. They produce the manure that grain farmers apply to their crops, and their manure storage and disposal practices can directly affect water quality. For example, manure that is improperly housed and sited (near streams or tributaries) is susceptible to runoff and leaching. In addition, field disposal of manure at rates above recommended plant nutrient needs also promotes runoff. Maryland has aggressively fought to improve poultry growers' nutrient-management practices through regulatory and voluntary programs. However, poultry growers dispose most of their manure by allowing grain farmers to apply it to their fields as fertilizer. In many cases, poultry growers are also grain farmers and use much of their manure in their own operations. Thus, grain farmers' nutrient-management decisions and practices ultimately determine field-application rates and play a major role in controlling nutrient runoff.

Chapter 6

[1]Efforts to understand other's cultural knowledge are always an imperfect enterprise. One's cultural knowledge is vast, context dependent, ever evolving, and difficult to articulate. Social scientists can at best capture some of the meaningful elements of this knowledge during any one research interval, and hope to improve upon it over time. As such, I do not claim that my cultural model for grain-farm management depicts all aspects of grain-farmer knowledge about grain production. In addition, I argue in Chapter 6 that Lower Eastern Shore grain farmers must consider a wide range of factors in making their grain production decisions. Given that many grain farmers also raise poultry, as well as participate in other money-making ventures, one consideration is how the demands of these activities will affect grain-farming decisions. One weakness of my grain-farm management model is that it does not necessarily capture the farm-management influences from these coexisting business pursuits. Unfortunately, I have insufficient data to provide this type of analysis. Additional research would be needed to determine the extent to which grain farmers who also raise poultry have a different grain-farm management model than farmers who just grow crops. Nevertheless, this potential limitation does not invalidate my grain-farm management model and discount the value of the shared farmer knowledge that comprises it. Instead, it suggests that my findings illuminate some of the key cultural elements that make up farmers' grain-farm management model and are an

important contribution to better understanding the cultural models that inform and direct their nutrient-management decisions.

[2]It is clear that farmers regularly depend on government subsidies like loan-deficiency payments (LDPs) to stay in business and make a living. As a result, their farm-management strategies include measures to best secure funds from these revenue sources. Some critics of LDPs and other farm-subsidy programs suggest that they encourage farmers to adopt management strategies that allow them to unduly profit from these programs. Even though Lower Eastern Shore grain farmers often spoke about their need for and feelings about government-subsidy programs like LDPs, they did not discuss their strategies for obtaining them. Thus, I was not able to factor this type of data into my depiction of their grain-farm management model.

Chapter 7

[1]Unlike many salaried jobs where one's income is relatively secure, and one can draw on the resources of one's employer to accomplish job-related activities, farmers are ultimately accountable for meeting their own needs. This does not mean that farmers do not rely on each other for help, or that they do not seek and receive financial and technical assistance from private institutions and government agencies. It does mean, however, that farmers' ability to survive is

primarily dependent on their own decisions, labor, and resources. If farmers fail in their production efforts, they have limited safety nets to rescue them.

[2]In saying that farmers' lives revolve around farm work, I do not mean to imply that they do not spend time socializing and recreating. In-between farm chores and during down periods, farmers routinely visit with friends and fellow farmers at local establishments (feed mills, diners, coffee shops, gas stations, quickie marts). Many also hunt and fish; attend their children's school and sporting events; volunteer time in civic, agrarian, and religious organizations; and participate in a wide range of everyday domestic affairs. Farmers work-in these activities into their farming schedules as time permits.

References Cited

Achenbach, Joel
2008 A "Dead Zone" in the Gulf of Mexico. WashingtonPost.Com (Washington, D.C.), July 31:A02. URL:<http://www.washingtonpost.com/wp-dyn/content/story/2008/07/31/ST2008073100349.html?hpid=moreheadlines> (January 1, 2009).

Agar, Michael H.
1980 Professional Stranger: An Informal Introduction to Ethnography. San Diego, Calif.: Academic Press.

Agriculture in the Classroom Program (ACP)
2008 A Look at Maryland Agriculture. State Agricultural Profiles. Washington, D.C.: Agriculture in the Classroom Program, U.S. Department of Agriculture. URL:<http://www.agclassroom.org/kids/stats/maryland.pdf> (January 1, 2009).

Albrecht, Don E.
1997 The Mechanization of Agriculture: A Historical Case Study of the Implications for Families and Communities. Culture & Agriculture 19:24-32.

Andrews, Emma
2008 Chesapeake Bay Tributary Basins. Maps. February 14. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/mapsearch.aspx?menuitem=14873> (May 21, 2009).

Barlett, Peggy F.
1989 Industrial Agriculture. *In* Economic Anthropology. Stuart Plattner, ed. Pp. 253-291. Calif.: Stanford University Press.

BayStat
2007 Lower Eastern Shore. Sources of the Problem. Annapolis: Maryland Department of Natural Resources. URL:<http://www.baystat.maryland.gov/sources2.html> (January 1, 2009).

Belousek, Darrin W.
2004 Scientific Consensus and Public Policy: The Case of *Pfiesteria*. The Journal of Philosophy, Science, and Law 4(August):1-33.

Belval, Donna L., and Lori A. Sprague
1999 Monitoring Nutrients in the Major Rivers Draining to Chesapeake Bay. Water-Resources Investigations Report No. 99-4238, November. Washington, D.C.: U.S. Geological Survey, U.S. Department of Interior. URL:<http://va.water.usgs.gov/online_pubs/WRIR/99-4238/wrir_99_4238_text.pdf> (January 1, 2009).

Bernard, H. Russell
1995 Research Methods in Anthropology: Qualitative and Quantitative Approaches. 2nd ed. Walnut Creek, Calif.: AltaMira Press.

Bernard, H. Russell, and Gery W. Ryan
1998 Text Analysis: Qualitative and Quantitative Methods. *In* Handbook of Methods in Cultural Anthropology. H. Russell Bernard, ed. Pp. 595-646. Walnut Creek, Calif.: AltaMira Press.

Blank, Steven C., Kenneth W. Erickson, and Charles B. Moss
2005 Profit Patterns across American Agriculture. Journal of Agricultural and Resource Economics 30(2):205-230.

Blankenship, Karl
1994 Maryland Nearly Halfway to Nutrient Management Goal: States Eye Expanded Use of Private Sector Agricultural Consultants. Bay Journal 4(9) December. URL:<http://www.bayjournal.com/article.cfm?article=2306&print=yes> (January 1, 2009).
1998 Maryland Enacts Nation’s Most Strict Nutrient Law. Bay Journal 8(3) May. URL:<http://www.bayjournal.com/article.cfm?article=1347> (January 1, 2009).
2004 Bay Cleanup Costs Could Top $30 Billion. Bay Journal 14(7) October. URL:<http://www.bayjournal.com/article.cfm?article=2378> (January 1, 2009).
2005 Many Maryland Farmers Missed Deadline for Nutrient Plans; D.C. May Get Environmental Agency; and More. Bay Journal 15(3) May. URL:<http://www.bayjournal.com/article.cfm?article=2537> (January 1, 2009).
2007a Trading Plans with Nonpoint Sources Could Cause Lag in Bay Cleanup. Bay Journal 17(5) July/August. URL:<http://www.bayjournal.com/article.cfm?article=3124> (January 1, 2009).
2007b Eastern Shore. Chesapeake Cleanup Update: Reductions in Nutrient, Sediment Loads Need to be Accelerated. Bay Journal 16(10) January. URL:<http://www.bayjournal.com/article.cfm?article=2981> (January 1, 2009).

Boesch, Donald F., Russell B. Brinsfield, and Robert E. Magnien
2001 Chesapeake Bay Eutrophication: Scientific Understandings, Ecosystem Restoration, and Challenges for Agriculture. Journal of Environmental Quality 30:303-320.

Boynton, W. R., J. H. Garber, R. Summers, and W. M. Kemp
1995 Inputs, Transformations, and Transport of Nitrogen and Phosphorus in Chesapeake Bay and Selected Tributaries. Estuaries 18(1B) March:285-314.

Brodie, Herbert L., and Royden N. Powell, III
1995 Agricultural Non-Point Source Water Pollution Control Voluntary Program in Maryland. *In* Animal Waste and the Land-Water Interface. Kenneth Steele, ed. Pp. 449-457. New York: Lewis Publishers.

Browner, Carol, and Dan Glickman
1998 Clean Water Action Plan: Restoring and Protecting America's Waters. Washington, D.C.: U.S. Environmental Protection Agency. URL:<http://water.usgs.gov/owq/cleanwater/action/cwap.pdf> (January 1, 2009).

Burkholder, Joann M., and Howard B. Glasgow, Jr.
1997 *Pfiesteria piscicida* and Other *Pfiesteria*-Like Dinoflagellates: Behavior, Impacts, and Environmental Controls. Limnology and Oceanography 42(5) Part 2:1052-1075.
2001 History of Toxic *Pfiesteria* in North Carolina Estuaries from 1991 to the Present. BioScience 51(10):827-841.

Butler, Jennifer S., and Frank J. Coale
2005 Phosphorus Leaching in Manure-Amended Atlantic Coastal Plain Soils. Journal of Environmental Quality 34(1):370-381.

Caswell, Margriet, Keith Fugile, Cassandra Ingram, Sharon Jans, and Catherine Kascak
2001 Adoption of Agricultural Production Practices: Lessons Learned from the U.S. Department of Agriculture Area Studies Project. Agricultural Economic Report No. 792, January. Washington, D.C.: Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. URL:<http://www.ers.usda.gov/publications/aer792/AER792.PDF> (January 1, 2009).

Chesapeake Bay Program (CBP)
n.d. Glossary. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/glossary.aspx?menuitem=14875> (January 1, 2009).

1982 Chesapeake Bay Program Technical Studies: A Synthesis. September. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/content/publications/cbp_13280.pdf> (January 1, 2009).

1990 Report and Recommendations of the Nonpoint Source Evaluations Panel. December. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/content/publications/cbp_12433.pdf> (January 1, 2009).

1992 Progress Report of the Baywide Nutrient Reduction Reevaluation. February. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/content/publications/cbp_12289.pdf> (January 1, 2009).

1997 1997 Nutrient Reduction Reevaluation Summary Report. Chesapeake Bay Nutrient Reduction Progress and Future Directions. EPA 903-R-97-030, CBP/TRS 189/97. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/pubs/97.pdf> (January 1, 2009).

1998 A Snapshot of Chesapeake Bay: How's It Doing? November 24. Annapolis, Md.: Chesapeake Bay Program.

2000 Chesapeake 2000. June 28. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/content/publications/cbp_12081.pdf> (January 1, 2009).

2004 About the Bay: Did You Know. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/about.htm> (January 1, 2009).

2005 Overview of the Bay Program: America's Premier Watershed Restoration Program. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/overview.htm> (January 1, 2009).

2007 Agricultural Sector Briefing: Implementation Committee for the Chesapeake Bay Program. April 19. Annapolis, Md.: Chesapeake Bay Program. URL:<http://archive.chesapeakebay.net/pubs/subcommittee/nsc/anrwg/AgriculturalSectorBriefingReport.pdf> (January 1, 2009).

2008a 2007 Chesapeake Bay Health and Restoration Assessment: A Report to the Citizens of the Bay Region. CBP/TRS-291-08, EPA-903-R-08-002. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/content/publications/cbp_26038.pdf> (January 1, 2009).

2008b About the Bay: Facts and Figures. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/factsandfigures.aspx?menuitem=14582> (January 1, 2009).

Coale, Frank J.

1996 Descriptions of the Soil Test Interpretive Categories Used by the University of Maryland Soil Testing Laboratory. SFM-3, August. College Park:

Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Pubs/SFM-3.pdf> (January 1, 2009).

2000 Phosphorus Dynamics in Soils of the Chesapeake Bay Watershed: A Primer. *In* Agriculture and Phosphorus Management: The Chesapeake Bay. Andrew N. Sharpley, ed. Pp. 43-55. Boca Raton, Fla.: Lewis Publishers.

2002 Agronomic Crop Nutrient Recommendations Based on Soil Tests and Yield Goals. SFM-1, October. College Park: Maryland Cooperative Extension, University of Maryland. URL:<http://extension.umd.edu/publications/PDFs/SFM1.pdf> (January 1, 2009).

2005a The Maryland Phosphorus Site Index: An Overview. SFM-6, April. College Park: Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Pubs/SFM-6.pdf> (January 1, 2009).

2005b The Maryland Phosphorus Site Index Technical Users Guide. SFM-7, April. College Park: Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Pubs/SFM-7.pdf> (January 1, 2009).

Coale, Frank J., and Joshua McGrath

2006 Converting Among Soil Test Analyses Frequently Used in Maryland. SFM-4, August. College Park: Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Pubs/SFM-4.pdf> (January 1, 2009).

Coale, Frank J., J. Thomas Sims, and April B. Leytem

2002 Accelerated Deployment of an Agricultural Nutrient Management Tool: The Maryland Phosphorus Site Index. Journal of Environmental Quality 31:1471-1476.

Code of Maryland (COMAR)

n.d.a Nutrient Management Certification and Licensing. Maryland Nutrient Management Regulations, 15.20.04.00. URL:<http://www.mda.state.md.us/pdf/ch4_new_nut_mgt_regs.pdf> (January 1, 2009).

n.d.b Manure Transportation Project. Maryland Nutrient Management Regulations, 15.20.05.00. URL:<http://www.mda.state.md.us/pdf/nmregs05.pdf> (January 1, 2009).

n.d.c Nutrient and Commercial Fertilizer Application Requirements for Agricultural Land and Land, Including State Property, Not Used for Agricultural Purposes. Maryland Nutrient Management Regulations, 15.20.06.00. URL:<http://www.mda.state.md.us/pdf/ch6_new_nut_mgt_regs.pdf> (January 1, 2009).

n.d.d Agricultural Operation Nutrient Management Plan Requirements. Maryland Nutrient Management Regulations, 15.20.07.00. URL:<http://www.mda.state.md.us/pdf/ch7_new_nut_mgt_regs.pdf> (January 1, 2009).

n.d.e Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation. Maryland Nutrient Management Regulations, 15.20.08.00. URL:<http://www.mda.state.md.us/pdf/ch8_new_nut_mgt_regs.pdf> (January 1, 2009).

Cover Crop Enhancement Work Group (CCEWG)
2008 Chesapeake Bay Cover Crop Enhancement Conference. Sponsored by the Chesapeake Bay Program's Scientific and Technical Advisory Committee. Grasonville, Maryland, December 18-19. URL:<http://www.chesapeake.org/stac/ccec.html> (January 1, 2009).

D'Andrade, Roy G.
1987 A Folk Model of the Mind. *In* Cultural Models in Language and Thought. Dorothy Holland and Naomi Quinn, eds. Pp. 112-148. New York: Cambridge University Press.
1992 Schemas and Motivation. *In* Human Motives and Cultural Models. Roy D'Andrade and Claudia Strauss, eds. Pp. 23-44. New York: Cambridge University Press.
1995 The Development of Cognitive Anthropology. New York: Cambridge University Press.
2005 Some Methods for Studying Cultural Cognitive Structures. *In* Finding Culture in Talk: A Collection of Methods. Naomi Quinn, ed. Pp. 83-104. New York: Palgrave Macmillan.

D'Andrade, Roy G., and Claudia Strauss, eds.
1992 Human Motives and Cultural Models. New York: Cambridge University Press.

Davidson, O. G.
1990 Broken Heartland: The Rise of America's Rural Ghetto. New York: The Free Press, Macmillan.

Delmarva Poultry Industry, Inc. (DPI)
2004 Delmarva Broiler Chicken Facilities. November. Georgetown, Del.: Delmarva Poultry Industry, Inc. URL:<http://www.dpichicken.org/download/Facilities%20Sheet.doc> (January 1, 2009).
2007 2006 State by State Broiler Chicken Production. April. Georgetown, Del.: Delmarva Poultry Industry, Inc. URL:<http://www.dpichicken.org/download/statebystates.doc> (January 1, 2009).
2008 Delmarva and U.S. Facts. May. Georgetown, Del.: Delmarva Poultry Industry, Inc. URL:<http://www.dpichicken.org/index.cfm?content=facts> (January 1, 2009).

Denver, Judith M., Scott W. Ator, Linda M. Debrewer, Matthew J. Ferrari, Jeffrey R. Barbaro, Tracy C. Hancock, Michael J. Brayton, and Mark R. Nardi
2004 Water Quality in the Delmarva Peninsula: Delaware, Maryland, and Virginia, 1999-2001. Circular 1228. Reston, Va.: U.S. Geological Survey. URL:<http://pubs.usgs.gov/circ/2004/1228/pdf/circular1228.pdf> (May 24, 2009).

Doehring, Todd A.
2001 Analyzing the Profitability of Your Operation. June. Savoy, Ill.: Ag Education & Consulting, LLC. URL:<http://www.centrec.com/resources/Articles/FinAnalysisFarmRanches/Profitability.pdf> (January 1, 2009).

Doering, Otto C., Francisco Diaz-Hermelo, Crystal Howard, Ralph Heimlich, Fred Hitzhusen, Richard Kazmierczak, John Lee, Larry Libby, Walter Milon, Tony Prato, and Marc Ribaudo
1999 Evaluation of the Economic Costs and Benefits of Methods for Reducing Nutrient Loads to the Gulf of Mexico: Topic 6 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico. Decision Analysis Series No. 20, May. Silver Spring, Md.: Coastal Ocean Program, National Oceanic and Atmospheric Administration. URL:<http://www.epa.gov/msbasin/pdf/hypox_t6final.pdf> (January 1, 2009).

Edwards, William
2006 Analyzing a Farm Income Statement. March. Ames: Agricultural Extension, Iowa State University. URL:<http://test.agmrc.org/agmrc/business/operatingbusiness/analyzingafarmincomestatement.htm> (January 1, 2009).

Ernst, Howard R.
2003 Chesapeake Bay Blues: Science, Politics, and the Struggle to Save the Bay. Lanham, Md.: Rowman and Littlefield.

Fahrenthold, David A.
2008 Broken Promises on the Bay: Chesapeake Progress Reports Painted “too Rosy a Picture” as Pollution Reduction Deadlines Passed Unmet. WashingtonPost.Com (Washington, D.C.), December 27:A01. URL:<http://www.washingtonpost.com/wp-dyn/content/story/2008/12/26/ST2008122601782.html> (January 1, 2009).

Favero, Philip
1997 Analyzing Nonpoint Source Water Pollution Problems: Nutrient Control Policies in the Chesapeake Bay States. October. College Park: Institute for Governmental Service, University of Maryland.

Fitchen, Janet
1991 Endangered Spaces, Enduring Places: Change, Identity, and Survival in Rural America. Boulder, Colo.: Westview Press.

Frossard, E., L. M. Condron, A. Oberson, S. Sinaj, and J. C. Fardeau
2000 Processes Governing Phosphorus Availability in Temperate Soils. Journal of Environmental Quality 29(1):15-23.

Gardner, Bruce L., Robert Chase, Michael Haigh, Erik Lichtenberg, Loretta Lynch, Wesley Musser, and Doug Parker
2002 Economic Situation and Prospects for Maryland Agriculture. Policy Analysis Report No. 02-01, September. College Park: Center for Agricultural and Natural Resource Policy, University of Maryland. URL:<http://www.nercrd.psu.edu/Publications/rdppapers/Report--Final.pdf> (January 1, 2009).

Goldschmidt, Walter Rochs
1978 As You Sow: Three Studies in the Social Consequences of Agribusiness. Montclair, N.J.: Allanheld, Osmun, and Company.

Goolsby, Donald A., William A. Battaglin, Gregory B. Lawrence, Richard S. Artz, Brent T. Aulenbach, Richard P. Hooper, Dennis R. Keeney, and Gary J. Stensland
1999 Flux and Sources of Nutrients in the Mississippi-Atchafalaya River Basin: Topic 3 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico. Decision Analysis Series No. 17. Silver Spring, Md.: Coastal Ocean Program, National Oceanic and Atmospheric Administration. URL:<http://oceanservice.noaa.gov/products/hypox_t3final.pdf> (January 1, 2009).

Grattan, Lynn M., David Oldach, and J. Glenn Morris, Jr.
2001 Human Health Risks of Exposure to *Pfiesteria piscicida*. BioScience 51(10):853-857.

Grattan, Lynn M., David Oldach, Trish M. Perl. Mark H. Lowitt, Diane L. Matuszak, Curtis Dickson, Colleen Parrott, Ritchie C. Shoemaker, C. Lisa Kauffman, Martin P. Wasserman, J. Richard Hebel, Patricia Charache, and J. Glenn Morris, Jr.
1998 Learning and Memory Difficulties after Environmental Exposure to Waterways Containing Toxin-Producing *Pfiesteria* or *Pfiesteria*-Like Dinoflagellate. The Lancet 352:532-539.

Griffith, David
1999 Exaggerating Environmental Health Risk: The Case of the Toxic Dinoflagellate *Pfiesteria*. Human Organization 58:119-127.

Hannah, James
2008 High Cost and Demand for Fertilizer Scares Farmers. The Associated Press (Washington, D.C.), June 4. URL:<http://www.newsvine.com/_news/2008/06/04/1538543-high-cost-and-demand-for-fertilizer-scares-farmers> (January 1, 2009).

Haygarth, P. M., and A. N. Sharpley
2000 Terminology for Phosphorus Transfer. Journal of Environmental Quality 29(1):10-15.

Herbst, Annemarie H.
2005 Regulating Farm Nutrient Runoff: Maryland's Experience with the Water Quality Improvement Act. Master thesis, Department of Urban Studies and Planning, Massachusetts Institute of Technology, June 28.

Higgs, B., A. E. Johnston, J. L. Salter, and C. J. Dawson
2000 Some Aspects of Achieving Sustainable Phosphorus Use in Agriculture. Journal of Environmental Quality 29(1):80-87.

Holland, Dorothy
1992 How Cultural Systems Become Desire: A Case Study of American Romance. *In* Human Motives and Cultural Models. Roy D'Andrade and Claudia Strauss, eds. Pp. 61-89. New York: Cambridge University Press.

Holland, Dorothy, and Naomi Quinn, eds.
1987 Cultural Models in Language and Thought. New York: Cambridge University Press.

Hotchkiss, Bruce
2008 Monsanto: Price of Some Seed Corn to Jump to $300. Delmarva Farmer (Easton, Md.), 33(24) August 12:1, 13. URL:<http://www.americanfarm.com/TopStory8.12.2008a.html> (January 1, 2009).

Hughes, Harry R.
1997 Blue Ribbon Citizens *Pfiesteria* Action Commission Final Report, November 3. Annapolis: Department of General Services, State of Maryland. URL:<http://www.dnr.state.md.us/Bay/cblife/algae/dino/pfiesteria/hughes_commission_report.pdf> (January 1, 2009).

Jones, Bryan D., Graeme Boushey, and Samuel Workman
2006 Behavioral Rationality and the Policy Processes: Toward a New Model of Organizational Information Processing. *In* Handbook of Public Policy. B. Guy Peters and Jon Pierre, eds. Pp. 49-74. Thousand Oaks, Calif.: Sage.

Kaiser, Jocelyn
2002 The Science of *Pfiesteria*: Elusive, Subtle, and Toxic. Science 298(11) October:346-349.

Lasley, Paul F., Larry Leistritz, Linda M. Labao, and Katherine Meyer
1995 Beyond the Amber Waves of Grain. Boulder, Colo.: Westview Press.

Leffler, Merrill
1997 Smart Farming for a Cleaner Bay. Maryland Marine Notes 15(3) May-June:1-4. College Park: Maryland Sea Grant, University of Maryland. URL:<http://www.mdsg.umd.edu/MarineNotes/May-June97/index.php> (January 1, 2009).

Lewins, Ann, and Christina Silver
2007 Using Software in Qualitative Research: A Step-by-Step Guide. Thousand Oaks, Calif.: Sage.

Lichtenberg, Erik
1996 Using Soil and Water Conservation Practices to Reduce Bay Nutrients: How has Agriculture Done? Economic Viewpoints 1(2):4-8. College Park: Maryland Cooperative Extension, University of Maryland.
2000 Soil and Water Conservation on Maryland Farms: A 1998 Update. Economic Viewpoints 4(1):5-7. College Park: Maryland Cooperative Extension, University of Maryland. URL:<http://mdagnrpolicy.arec.umd.edu/Publications/evdocs/eccol4no1s2000_Lichtenberg.htm> (January 1, 2009).

LiveScience Staff
2008 Gulf Dead Zone May Grow Larger than Ever. USNews.Com (New York), July 15. URL:<http://www.usnews.com/articles/science/environment/2008/07/15/gulf-dead-zone-may-grow-larger-than-ever.html> (January 1, 2009).

Magnien, Robert E.
2001 The Dynamics of Science, Perception, and Policy during the Outbreak of *Pfiesteria* in the Chesapeake Bay. Bioscience 51(10):843-852.

Magnien, Robert E., D. Boward, and S. Bieber, eds.

1995 The State of the Chesapeake 1995. Annapolis, Md.: U.S. Environmental Protection Agency.

Maguire, R. O., J. Thomas Sims, and Frank J. Coale

2000 Phosphorus Solubility in Biosolids-Amended Farm Soils in the Mid-Atlantic Region of the USA. Journal of Environmental Quality 29(4):1225-1233.

Maloney, R. Shawn

1998 A Study of the Cultural Models of *Pfiesteria piscicida*. Funded proposal submitted to the Society for Applied Anthropology's and the U.S. Environmental Protection Agency's Office of Sustainable Ecosystems and Communities joint Environmental Anthropology Fellowship Program. Author's files.

Maloney, R. Shawn, and Michael Paolisso

2001 What Can Digital Audio Data Do for You? Field Methods 13:88-96.

2006 The "Art of Farming": Exploring the Link between Farm Culture and Maryland's Nutrient Management Policies. Culture & Agriculture 28:80-96.

Maryland Cooperative Extension (MCE)

1995 Focus on Nitrogen. Nutrient Manager 2(1) Summer:1-4. College Park: Agricultural Nutrient Management Program, Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Pubs/N_newsltr.pdf> (January 1, 2009).

1997 Focus on Phosphorus. Nutrient Manager 4(1):1-4. College Park: Agricultural Nutrient Management Program, Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Pubs/P_newsltr.pdf> (January 1, 2009).

2001 Focus on Phosphorus Site Index. Nutrient Manager 8(1) Summer:1-4. College Park: Agricultural Nutrient Management Program, Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Pubs/PSI_newsltr.pdf> (January 1, 2009).

2006a How the MCE Agricultural Nutrient Management Program Got Started. History of the Nutrient Management Program. College Park: Agricultural Nutrient Management Program, Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Bkgrnd/History.html> (January 1, 2009).

2006b Nutrient Applicator Training Guide. College Park: Agricultural Nutrient Management Program, Maryland Cooperative Extension, University of Maryland. URL:<http://anmp.umd.edu/Resources/nut_app_guide.pdf> (January 1, 2009).

Maryland Department of Agriculture (MDA)
n.d. Maryland Nutrient Management Manual. Annapolis: Maryland Department of Agriculture. URL:<http://www.mda.state.md.us/resource_conservation/nutrient_management/manual/index.php> (January 1, 2009).
2006 Maryland Department of Agriculture 2005 Annual Report: Preserving Farmland, Protecting Consumers, Promoting Profitable Agriculture. Annapolis: Maryland Department of Agriculture. URL:<http://www.mda.state.md.us/pdf/05mda_ar.pdf> (January 1, 2009).
2007 2006 Annual Report: Standing Tall, Nutrient Management in Maryland. Annapolis: Nutrient Management Program, Maryland Department of Agriculture. URL:<http://www.mda.state.md.us/pdf/nmar06.pdf> (January 1, 2009).
2008a 2007 Annual Progress Report: Implementing Nutrient Management in Maryland. Annapolis: Nutrient Management Program, Maryland Department of Agriculture. URL:<http://www.mda.state.md.us/pdf/nmar07.pdf> (January 1, 2009).
2008b Compliance Update. Maryland Nutrient Management News, Spring/Summer. Annapolis: Nutrient Management Program, Maryland Department of Agriculture.

Maryland Department of Natural Resources (MDNR)
2007a Maryland Tributary Strategy Lower Eastern Shore Basin Summary Report for 1985-2005 Data. August. Annapolis: Maryland Department of Natural Resources. URL:<http://www.dnr.state.md.us/bay/pdfs/LESbasinsum8505FINAL2007.pdf> (January 1, 2009).
2007b Maryland Tributary Strategy Upper Eastern Shore Basin Summary Report for 1985-2005 Data. August. Annapolis: Maryland Department of Natural Resources. URL:<http://www.dnr.state.md.us/bay/pdfs/UESBasinSum8505FINAL07.pdf> (January 1, 2009).
2007c Maryland Tributary Strategy Choptank River Basin Summary Report for 1985-2005 Data. August. Annapolis: Maryland Department of Natural Resources. URL:<http://www.dnr.state.md.us/bay/pdfs/ChoptankBasinSum8505FINAL07.pdf> (January 1, 2009).
2008 Maryland's Chesapeake Bay Tributary Strategy Statewide Implementation Plan. January 4. Annapolis: Maryland Department of Natural Resources. URL:<http://www.dnr.state.md.us/BAY/tribstrat/TribDocumentFinal_012308.pdf> (January 1, 2009).

Maryland Department of Planning (MDP)
n.d. Generalized Zoning in Maryland. Baltimore: Maryland Department of Planning. URL:<http://www.mdp.state.md.us/pdf/nwgene.pdf> (May 26, 2009).

Maryland General Assembly (MGA)
1998 Water Quality Improvement Act. Chapters 324 and 325, Laws of Maryland. Annapolis: Maryland Department of Legislative Services.

Maryland Office of Tourism Development (MOTD)
2008 Maryland Tourism Fast Facts 2008. Baltimore: Maryland Office of Tourism Development. URL:<http://167.102.232.26/resources/FastFacts2008Final3forWeb.pdf> (January 1, 2009).

Maryland State Data Center (MSDC)
2002a State of Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning. URL:<http://www.mdp.state.md.us/msdc/census/cen2000/sf3/sumyprof/DP1_4/04024.pdf> (January 1, 2009).

2002b Somerset County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning. URL:<http://www.mdp.state.md.us/msdc/census/cen2000/sf3/sumyprof/DP1_4/05024039.pdf> (January 1, 2009).

2002c Wicomico County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning. URL:<http://www.mdp.state.md.us/msdc/census/cen2000/sf3/sumyprof/DP1_4/05024045.pdf> (January 1, 2009).

2002d Worcester County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland

Department of Planning.
URL:<http://www.mdp.state.md.us/msdc/census/cen2000/sf3/sumyprof/DP1_4/05024047.pdf> (January 1, 2009).

2002e Caroline County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning.
URL:<http://www.mdp.state.md.us/msdc/census/cen2000/SF3/sumyprof/DP1_4/05024011.pdf> (January 1, 2009).

2002f Dorchester County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning.
URL:<http://www.mdp.state.md.us/msdc/census/cen2000/SF3/sumyprof/DP1_4/05024019.pdf> (January 1, 2009).

2002g Kent County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning.
URL:<http://www.mdp.state.md.us/msdc/census/cen2000/SF3/sumyprof/DP1_4/05024029.pdf> (January 1, 2009).

2002h Cecil County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning.
URL:<http://www.mdp.state.md.us/msdc/census/cen2000/SF3/sumyprof/DP1_4/05024015.pdf> (January 1, 2009).

2002i Queen Anne’s County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning.
URL:<http://www.mdp.state.md.us/msdc/census/cen2000/SF3/sumyprof/DP1_4/05024035.pdf> (January 1, 2009).

2002j Talbot County, Maryland. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. May 29 release date. Annapolis: Maryland State Data Center, Maryland Department of Planning. URL:<http://www.mdp.state.md.us/msdc/census/cen2000/SF3/sumyprof/DP1_4/05024041.pdf> (January 1, 2009).

Maryland Transportation Authority (MTA)
2008 Chesapeake Bay Bridge Fast Facts. Baltimore: Maryland Transportation Authority. URL:<http://www.mdkidspage.org/BayBridge.htm> (January 1, 2009).

Mathews, Holly F.
2005 Uncovering Cultural Models of Gender from Accounts of Folktales. *In* Finding Culture in Talk: A Collection of Methods. Naomi Quinn, ed. Pp. 105-155. New York: Palgrave Macmillan.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (MRGOMWNTF)
2008 Gulf Hypoxia Action Plan 2008 for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico and Improving Water Quality in the Mississippi River Basin. Washington, D.C.: U.S. Environmental Protection Agency. URL:<http://www.epa.gov/msbasin> (January 1, 2009).

Muhr, Thomas
2006 The Software: Atlas.ti 5.2.6. Berlin, Ger.: Scientific Software Development.

National Agricultural Statistics Service (NASS)
2004a Maryland State and County Data. Volume 1, Geographic Area Series, Part 20. AC-02-A-20. 2002 Census of Agriculture. June. Washington, D.C.: National Agricultural Statistics Service, U.S. Department of Agriculture. URL:<http://www.nass.usda.gov/census/census02/volume1/md/MDVolume104.pdf> (January 1, 2009).
2004b United States Summary and State Data. Volume 1, Geographic Area Series, Part 51. AC-02-A-51. 2002 Census of Agriculture. June. Washington, D.C.: National Agricultural Statistics Service, U.S. Department of Agriculture. URL:<http://www.agcensus.usda.gov/Publications/2002/Volume_1,_Chapter_1_US/USVolume104.pdf> (January 1, 2009).

National Association of State Departments of Agriculture (NASDA)
2007 Maryland Agriculture Officials Announce Nutrient Management Progress Enforcement to Ramp Up. Washington, D.C.: National Association of State Departments of Agriculture. URL:<http://www.nasda.org/cms/7197/9060/14101/14106.aspx> (January 1, 2009).

Offices of Inspector General (OIG)
2006 Evaluation Report: Saving the Chesapeake Bay Watershed Requires Better Coordination of Environmental and Agricultural Resources. EPA OIG Report No. 2007-P-00004, USDA OIG Report No. 50601-10-Hq, November 20. Washington, D.C.: Offices of Inspector General, U.S. Environmental Protection Agency and U.S. Department of Agriculture. URL:<http://www.epa.gov/oig/reports/2007/20061120-2007-P-00004.pdf> (January 1, 2009).
2007 Evaluation Report: Development Growth Outpacing Progress in Watershed Efforts to Restore the Chesapeake Bay. Report No. 2007-P-00031, September 10. Washington, D.C.: Office of Inspector General, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/oig/reports/2007/20070910-2007-P-00031.pdf> (January 1, 2009).
2008 Evaluation Report: EPA Needs to Better Report Chesapeake Bay Challenges, A Summary Report. Report No. 08-P-0199, July 14. Washington, D.C.: Office of Inspector General, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/oig/reports/2008/20080714-08-P-0199.pdf> (January 1, 2009).

Paolisso, Michael
1999 Toxic Algal Blooms, Nutrient Runoff, and Farming on Maryland's Eastern Shore. Culture & Agriculture 21:53-58.
2002 Blue Crabs and Controversy on the Chesapeake Bay: A Cultural Model for Understanding Watermen's Reasoning about Blue Crab Management. Human Organization 61:226-239.

Paolisso, Michael, and Erve Chambers
2001 Culture, Politics, and Toxic Dinoflagellate Blooms: The Anthropology of *Pfiesteria*. Human Organization 60:1-12.

Paolisso, Michael, Erve Chambers, and R. Shawn Maloney
1998a A Study of the Cultural Models of *Pfiesteria piscicida*. Funded proposal submitted to National Science Foundation's Cultural Anthropology Program. Award no. 9813448. Prepared by members of the Resource Management and Cultural Process Track, Department of Anthropology, University of Maryland, College Park. Author's files.

1998b A Study of the Cultural Models of *Pfiesteria piscicida*: Maryland Sea Grant Proposal to Supplement National Science Foundation Funded Research. Funded proposal submitted to Maryland Sea Grant at the University of Maryland, College Park. Prepared by members of the Resource Management and Cultural Process Track, Department of Anthropology, University of Maryland, College Park. Author's files.

1999a Cultural Consensus and Cultural Models of Environment on Maryland's Lower Eastern Shore. Funded proposal submitted to National Science Foundation's Cultural Anthropology Program. Award no. 9904928. Prepared by members of the Resource Management and Cultural Process Track, Department of Anthropology, University of Maryland, College Park. Author's files.

1999b Applying Consensus and Cultural Models to Improve Environmental Decision-Making. Funded proposal submitted to the U. S. Environmental Protection Agency and National Science Foundation Partnership for Environmental Research Decision-Making and Valuation for Environmental Policy. Award no. 9975825. Prepared by members of the Resource Management and Cultural Process Track, Department of Anthropology, University of Maryland, College Park. Author's files.

Paolisso, Michael, and R. Shawn Maloney

2000a Farmer Morality and Maryland's Nutrient Management Regulations. Culture & Agriculture 22:32-39.

2000b Recognizing Farmer Environmentalism: Nutrient Runoff and Toxic Dinoflagellate Blooms in the Chesapeake Bay Region. Human Organization 59:209-221.

Quinn, Naomi

1987 Convergent Evidence for a Cultural Model of American Marriage. *In* Cultural Models in Language and Thought. Dorothy Holland and Naomi Quinn, eds. Pp. 173-192. New York: Cambridge University Press.

1992 The Motivational Force of Self-Understanding: Evidence from Wives' Inner Conflicts. *In* Human Motives and Cultural Models. Roy D'Andrade and Claudia Strauss, eds. Pp. 90-126. New York: Cambridge University Press.

1997 Research on Shared Task Solutions. *In* A Cognitive Theory of Cultural Meaning. Claudia Strauss and Naomi Quinn, eds. Pp. 137-188. New York: Cambridge University Press.

2005b How to Reconstruct Schemas People Share, From What They Say. *In* Finding Culture in Talk: A Collection of Methods. Naomi Quinn, ed. Pp. 35-81. New York: Palgrave Macmillan.

2005c Introduction. *In* Finding Culture in Talk: A Collection of Methods. Naomi Quinn, ed. Pp. 1-34. New York: Palgrave Macmillan.

Quinn, Naomi, ed.
2005a Finding Culture in Talk: A Collection of Methods. New York: Palgrave Macmillan.

Quinn, Naomi, and Dorothy Holland
1987 Culture and Cognition. *In* Cultural Models in Language and Thought. Dorothy Holland and Naomi Quinn, eds. Pp. 3-40. New York: Cambridge University Press.

Ribaudo, Marc O., Richard D. Horan, and Mark E. Smith
1999 Economics of Water Quality Protection from Nonpoint Sources: Theory and Practice. Agricultural Economic Report No. 782, November. Washington, D.C.: Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. URL:<http://www.ers.usda.gov/publications/aer782/aer782.pdf> (January 1, 2009).

Ribaudo, Marc O., and Robert Johansson
2006 Water Quality: Impacts of Agriculture. *In* Agricultural Resources and Environmental Indicators. Economic Information Bulletin No. 16, July. Keith Wiebe and Noel Gollehon, eds. Pp. 33-41. Washington, D.C.: Economic Research Service, U.S. Department of Agriculture. URL:<http://www.ers.usda.gov/publications/arei/eib16/eib16_2-2.pdf> (January 1, 2009).

Ryan, Gery W., and H. Russell Bernard
2003 Techniques to Identify Themes. Field Methods 15:85-109.

Satterfield, Bill
2007 Delmarva's Poultry Industry and Environmental Protection. Georgetown, Del.: Delmarva Poultry Industry, Inc. URL:<http://www.dpichicken.org/index.cfm?content=facts> (January 1, 2009).

Science Advisory Board Hypoxia Panel (SABHP)
2007a Science Advisory Board Hypoxia Panel Draft Advisory Report. November 5. Washington, D.C.: Science Advisory Board, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/sab/pdf/11-5-07_hap_draft.pdf> (January 1, 2009).
2007b Hypoxia in the Northern Gulf of Mexico: An Update by the EPA Science Advisory Board. EPA-SAB-08-003, December 21. Washington, D.C.: Science Advisory Board, U.S. Environmental Protection Agency. URL:<http://yosemite.epa.gov/sab/sabproduct.nsf/C3D2F27094E03F90852573B800601D93/$File/EPA-SAB-08-003complete.unsigned.pdf> (January 1, 2009).

ScienceDaily
2008 Record-Setting Dead Zones Predicted for Gulf of Mexico, Chesapeake Bay. ScienceDaily (Rockville, Md.), July 17. URL:<http://www.sciencedaily.com/releases/2008/07/080714160000.htm> (January 1, 2009).

Scientific and Technical Advisory Committee (STAC)
2004 Innovation in Agricultural Conservation for the Chesapeake Bay: Evaluating Progress and Addressing Future Challenges. A white paper from the Scientific and Technical Advisory Committee (STAC), Chesapeake Bay Program, STAC Publication 04-003, February. Edgewater, Md.: Chesapeake Research Consortium. URL:<http://www.chesapeakebay.net/content/publications/cbp_13325.pdf> (January 1, 2009).

Sharpley, Andrew N., ed.
2000 Agriculture and Phosphorus Management: The Chesapeake Bay. Boca Raton, Fla.: Lewis Publishers.

Sharpley, Andrew N., Bob Foy, and Paul Withers
2000 Practical and Innovative Measures for the Control of Agricultural Phosphorus Losses to Water: An Overview. Journal of Environmental Quality 29(1):1-10.

Shore, Bradd
1996 Culture in Mind: Cognition, Culture, and the Problem of Meaning. New York: Oxford University Press.

Simpson, Thomas W.
n.d. A Citizen's Guide to the Water Quality Improvement Act of 1998. College Park: Maryland Cooperative Extension, College of Agriculture and Natural Resources, University of Maryland. URL:<www.agnr.umd.edu/waterquality/WQ.html> (January 1, 2009).

Sims, J. Thomas, and Frank J. Coale
2002 Solutions to Nutrient Management Problems in the Chesapeake Bay Watershed, USA. *In* Agriculture, Hydrology, and Water Quality. P. M. Haygarth and S. C. Jarvis, eds. Pp. 345-371. New York: CABI Publishing.

Sims, J. Thomas, A. C. Edwards, O. F. Schoumans, and R. R. Simard
2000 Integrating Soil Phosphorus Testing into Environmentally Based Agricultural Management Practices. Journal of Environmental Quality 29(1):60-71.

Smith, Midge, F.
1998 Nutrient Management Practices of Farmers in Pocomoke River Watershed--1996. June. College Park: College of Agriculture and Natural Resources, University of Maryland. URL:<http://anmp.umd.edu/Resources/Implement_Studies.html> (January 1, 2009).
1999 Evaluation of Maryland's Statewide Nutrient Management Program. September. College Park: College of Agriculture and Natural Resources, University of Maryland. URL:<http://anmp.umd.edu/Resources/Implement_Studies.html> (January 1, 2009).

Smullen, James T., Jay L. Taft, and Joseph Macknis
1982 Nutrient and Sediment Loads to the Tidal Chesapeake Bay System. *In* Chesapeake Bay Program Technical Studies: A Synthesis. September, Pp. 150-265. Washington, D.C.: Chesapeake Bay Program, U.S. Environmental Protection Agency. URL:<http://www.chesapeakebay.net/content/publications/cbp_13280.pdf> (January 1, 2009).

South Dakota Cooperative Extension (SDCE)
2003 Using Manure Analysis Results. SD-NRCS-FS-38, March. Brookings: South Dakota Cooperative Extension, South Dakota State University. URL:<http://www.state.sd.us/DENR/DFTA/WatershedProtection/P2/Documents/Analysis.pdf> (January 1, 2009).

Staver, Kenneth W., and Russell B. Brinsfield
2001 Agriculture and Water Quality on the Maryland Eastern Shore: Where Do We Go from Here? Bioscience 51(10) October:859-868.

Strauss, Claudia
1992 Models and Motives. *In* Human Motives and Cultural Models. Roy D'Andrade and Claudia Strauss, eds. Pp. 1-20. New York: Cambridge University Press.

Strauss, Claudia, and Naomi Quinn
1997 A Cognitive Theory of Cultural Meaning. New York: Cambridge University Press.

Terlizzi, Dan E.
2006 *Pfiesteria* Hysteria, Agriculture, and Water Quality in the Chesapeake Bay: The Extension Bridge over Troubled Waters. Journal of Extension 44(5) October:1-9. URL:<http://www.joe.org/joe/2006october/a3.shtml> (January 1, 2009).

Travel Industry Association (TIA)
2007 The Economic Impact of Travel on Maryland Counties: 2006. A Study Prepared for the Maryland Office of Tourism Development. November. Washington, D.C.: Travel Industry Association. URL:<http://167.102.232.26/resources/MD%202006%20Report.pdf> (January 1, 2009).

Tri-County Council (TCC)
2007 Comprehensive Economic Development Strategy for the Lower Eastern Shore of Maryland. July. Tri-County Council for the Lower Eastern Shore of Maryland. URL:<http://www.lowershore.org/PDF/CEDS/CEDS2007.pdf> (January 1, 2009).

U.S. Census Bureau
2002 United States. Table DP-1: Profile of General Demographic Characteristics. Table DP-2: Profile of Selected Social Characteristics. Table DP-3: Profile of Selected Economic Characteristics. Table DP-4: Profile of Selected Housing Characteristics. Census 2000 Summary File 4. Washington, D.C.: U.S. Census Bureau. URL:<http://factfinder.census.gov/servlet/DatasetMainPageServlet?_ds_name=DEC_2000_SF4_U&_program=DEC&_lang=en> (January 1, 2009).
2008a Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24000.html> (January 1, 2009).
2008b Somerset County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24039.html> (January 1, 2009).
2008c Wicomico County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24045.html> (January 1, 2009).
2008d Worcester County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24047.html> (January 1, 2009).
2008e Caroline County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24011.html> (January 1, 2009).
2008f Dorchester County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24019.html> (January 1, 2009).
2008g Kent County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24029.html> (January 1, 2009).

2008h Cecil County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24015.html> (January 1, 2009).

2008i Queen Anne's County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24035.html> (January 1, 2009).

2008j Talbot County, Maryland Geography QuickFacts. State and County QuickFacts. July 25. Washington, D.C.: U.S. Census Bureau. URL:<http://quickfacts.census.gov/qfd/states/24/24041.html> (January 1, 2009).

U.S. Environmental Protection Agency (EPA)

1998 Water Pollution Control: 25 Years of Progress and Challenges for the New Millennium. EPA-833-F-98-003, June. Washington, D.C.: Office of Wastewater Management, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/npdes/pubs/25PROG.PDF> (January 1, 2009).

2000a Chapter 10: Controlling Nonpoint Sources. National Water Quality Inventory: 1998 Report to Congress. EPA 841-R-00-001. Washington, D.C.: Office of Waster, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/305b/98report/> (January 1, 2009).

2000b The Quality of Our Nation's Waters. A Summary of the National Water Quality Inventory: 1998 Report to Congress. EPA 841-S-00-001, June. Washington, D.C.: Office of Water, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/305b/98report/98brochure.pdf> (January 1, 2009).

2003 National Management Measures for the Control of Nonpoint Pollution from Agriculture. EPA 841-B-03-004, July. Washington, D.C.: Office of Water, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/owow/nps/agmm/> (January 1, 2009).

2007a National Water Quality Inventory: Report to Congress, 2002 Reporting Cycle. EPA 841-R-07-001, October. Washington, D.C.: Office of Water, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/305b/2002report/report2002305b.pdf> (January 1, 2009).

2007b The National Water Quality Inventory: Report to Congress for the 2002 Reporting Cycle--A Profile. EPA 841-F-07-003, October. Washington, D.C.: Office of Water, U.S. Environmental Protection Agency. URL:<http://www.epa.gov/305b/2002report/factsheet2002305b.pdf> (January 1, 2009).

University of Maryland Center for Environmental Science (UMCES) and National Oceanic and Atmospheric Administration (NOAA)

2008 Chesapeake Bay Health Report Card: 2007. April. University of Maryland Center for Environmental Science and National Oceanic and Atmospheric Administration. URL:<http://www.eco-check.org/reportcard/chesapeake/2007/> (January 1, 2009).

Ventsias, Tom
2002 Waste Not, Want Not: Putting Delmarva's Poultry Litter to Good Use. Maryland Research Magazine 11(2) Spring:1-6. College Park: University of Maryland. URL:<http://www.marylandresearch.umd.edu/issues/spring2002/feature.html> (January 1, 2009).

Weinberg, Howard
2008 Chesapeake Bay Counties. Maps. July 22. Annapolis, Md.: Chesapeake Bay Program. URL:<http://www.chesapeakebay.net/mapsearch.aspx?menuitem=14873> (May 21, 2009).

Wheeler, Timothy B.
2008 Group Calls for Better Bay Restoration Effort. BaltimoreSun.Com (Baltimore, Md.), December 9. URL:<http://www.baltimoresun.com/news/local/bal-md.bay09dec09,0,4684055.story> (January 1, 2009).

White, Brian
2008 Scientists Say Current Bay Cleanup a Failure. The Associated Press (Washington, D.C.), December 8. URL:<http://www.examiner.com/a-1732769~Scientists_say_current_bay_cleanup_a_failure.html> (January 1, 2009).

Wood, Pamela
2008 Bay Restoration Efforts Show Few Positive Results after 25 Years. Capital Gazette Newspaper (Annapolis, Md.), December 7. URL:<http://www.hometownannapolis.com/cgi-bin/read/2008/12_07-50/TOP> (January 1, 2009).